Approaches to Transit Oriented Development:
How existing infrastructure can lend itself to implementation of Transit Oriented Development Techniques

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A Thesis Presented to
Columbia University
Graduate School of Architecture Planning and Preservation
In the City of New York

In partial fulfillment of the requirements
For the degree of Master of Science in Urban Planning

By

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May 2018

Abstract

Sprawl as the main development type in America has made communities disconnected and resulted in Americans spending large amounts of time in their cars. In response to this, many parts of the country have begun reviving their downtowns and improving transit accessibility, embracing transit-oriented development (TOD) as a method of doing so. TOD aims to provide connectivity, more sustainable living, and a better community environment through mixing uses, increasing density, and providing transit, though the aspect of providing transit is mostly centered around introducing rail.

This research investigates potential for transit-oriented development in the State of New Jersey using a spatial multi-criteria analysis, focusing on characteristics of employment, population density, intersection density and land use, excluding the characteristic of transportation. This aims to identify areas that show how transit may not need to be the first step in introducing TOD, but rather can be worked toward as a goal of TOD.

Results of this research indicate that other characteristics of TOD such as connectivity, land use, and density can be worked on in order to help municipalities get to a point where they can sustain transit, a sort of reverse approach not often discussed in policy around TOD. This research also supports the option of looking at transit options outside rail, specifically embracing TOD developed around bus transit options, which may be cheaper to implement considering the extensive existing network in Northern New Jersey.

Acknowledgements

I would like to thank my thesis advisor Leah Meisterlin for her guidance and encouragement throughout the process and contagious enthusiasm for the subject of spatial analysis.

I would also like to thank my thesis group classmates for their feedback and help in brainstorming sessions as well as all of my classmates in the class of 2018 who helped provide support and feedback throughout the process.

I would like to thank my parents Michael and Diane Semeraro for their support throughout my life and education.

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Chapter 1: Background

Introduction

Transit-oriented development (TOD) today is recognized as a development type that forms communities, stresses the importance of human interaction, and the importance of proximity for that connection. From interpersonal relationships to business relationships, the ability to be physically present and in a location that is accessible has fueled many trends in development prompting states and cities to implement policy programs to return development typology from suburban sprawl to dense walkable areas, more similar to what it was before the invention of the car. Transit-oriented development also often requires existing transit to be considered a proper TOD, an assumption that this research challenges proposing other important characteristics for this development type and the concept of bringing in transit through TOD rather than only executing it around existing transit.

Similar to transit-oriented development is the concept of smart growth. Smart growth is a method which allows municipalities, states, or townships to plan growth in order to preserve open space, minimize pollution and promote economic success. Transit-oriented development is a development type which fits within the goals of smart growth and is used often in areas identified as having potential to execute "smart growth" strategies. Smart growth and transit-oriented development have been embraced over the years in the United States, to a point where methods have developed by researchers and governments on how to measure this type of development or lack thereof for different goals and purposes. Some research on this is executed in order to identify what areas have the propensity for this development, to provide some proof of its eventual success prior to investing funding in executing policy and master plans related to these changes. These systems of measurement and analysis can be opportunities not only to pre-

identify locations, but with the current history of development are also opportunities to look at areas where these policies have already been implemented and learn from them.

This research looks at the current trends of transit-oriented development in the state of New Jersey through the lens of geospatial analysis. This study provides an index of measuring TOD Characteristics in order to identify areas that have strong characteristics. While many policies and definitions of TOD center on the availability of transit, this study proposes a focus on the other attributes of TOD (excluding transit) in order to view a sites potential for smart growth. The study provides a method of identifying areas that may not have the typical anchoring characteristics of TOD such as a major rail station that are typically found in government supported municipalities but still benefit from characteristics such as increased walkability, higher densities, and increased mixed-use development.

New Jersey agencies have been focused on smart growth and transit-oriented development for many years, providing many resources for municipalities to take advantage of. This focus has resulted in a number of municipalities which have made this commitment to develop in a more planned way and with transit in mind, one of them being the Transit Village Program. This program, which provides assistance to towns, gives one perspective of what successful transit-oriented development is, and these designations will be analyzed and used in comparison to non-designated municipalities in this study.

This research looks at if non-Transit Village towns can achieve the same measurable characteristics as designated Transit Villages, with the aim of suggesting municipalities consider developing with the intent of improving transit access, even if the existing state of the municipality has limited transit access. This research method uses geospatial measurements to

determine characteristics of density, land use, and connectivity, while on a local level seeing what similar actions these municipalities have taken on a policy level to achieve goals of TOD.

Transit-Oriented Development History

The concept of transit-oriented development existed long before the term itself was created and has a strong history in America from before the personal vehicle was a primary transit option. Prior to the widespread use of the car, development was much more pedestrian focused and occurred around public transit options such as trains and streetcars. At this time rail was the only long-distance transit option, and dense walkable environments were necessary to support daily life (Carlton 2007).

Transit-oriented development (TOD) as we know it today was not introduced until the late 1980s and early 1990s as a way to densify neighborhoods, reduce auto dependence, reduce congestion and allow for better community building. These were all goals desired after years of vehicular-driven development spread people apart and reduced community engagement and human activity.

The term transit-oriented development is attributed to Peter Calthorpe, who outlined the concept in his book *The Next American Metropolis* (Calthorpe 1993). Calthorpe details what urbanism could look like in a more suburban context. Calthorpe discusses sustainable building methods that were abandoned during the phase of development in America that resulted in sprawl. Calthorpe's intent was not to create a new concept but to revive movements of the past, comparing his theory with that of the Garden Cities, street car suburbs, and the City Beautiful Movement (Calthorpe 1993). His focus was not to reinvent a development type but readopt a

successful typology that creates place for communities more effectively than the sprawl that was prevalent throughout the nation in the 1900s.

Calthorpe discusses the crisis of place in America, outlining the negative impacts that suburban growth has had on the environment, from pollution, congestion, loss of affordability, and isolation. The need for affordability, infill development, and preservation of the natural ecology are all concerns which TOD has ways of addressing. While in previous centuries this method of development occurred naturally, Calthorpe identifies guidelines and standards for executing this development type in today's society all, which speak to the ailments of sprawled development on our communities. Guidelines for TOD return our understanding of neighborhood development to what it was years ago, identifying the need for mixed uses, methods for preservation of natural resources, drainage guidelines, suggestions on physical form and setbacks, and density explanations around types of residential development (Calthorpe 1993). His focus is strongly on issues not related directly to transit but all help in creating a development typology that he indicates is healthier and better for the human experience.

Guidelines included for this development typology include the need to review parking standards and an explanation that parking should be reduced in TOD areas. Suggestions included that park-and-rides should be reserved for end of line transit stops to avoid using land in proximity to transit for a non-stimulating land use surrounding stations, opting for commercial and residential instead. The book ends with case studies of this type of development which include Portland, Sacramento, San Diego, and others, mostly in the state of California (Calthorpe 1993). The examples given, show an early resurgence of dense development often attributed as a response to the heavy congestion that developed in areas like Los Angeles as a result of sprawl and growing auto use.

Calthorpe's writings have been expanded on and his guidelines used in development across the country since the original publication. In his later book *The Regional City,* Calthorpe (2001) expands on one of the concepts he mentions in *The Next American Metropolis*, which is the need for regional planning and coordination to succeed in sustainable development.

The success of TOD at this point has been well documented; younger generations desire the freedom and accessibility that cities provide and baby boomers are downsizing and looking for ways to keep their mobility in old age. Both generations see cities and TOD towns as ideal living situations, proving demand for this type of development. Research and social response has given strong evidence that this is a development trend that will continue to be embraced across the country (Chatman 2013). Research on performance of transit-oriented developments has confirmed reduced car ownership and increased transit usage. Diverse land uses, a tenet of TOD, have been shown to increase active transit trips for non-work trips, such as walking to the grocery store or to pick up dry cleaning. Many of these benefits have arisen from TOD development criteria of increased residential density, lower parking ratios, mixed uses, and highquality walking and cycling environments (Chatman, 2010).

This current perception has come a long way from the origination of the early concept penned by Calthorpe. In the early years of the concept many began to embrace the idea of transitoriented development, however others were hesitant, stating the Calthorpe approach was untested (Newman 1991). The body of research that has been executed shows that, over the decades of implementation and measurement, the approach has been tested and proven to achieve the goals it set out to at its early conception (Newman 1991).

Methodology Lit Review

Methodology: Spatial Analysis

This research proposal looks first at spatial measurements to determine on a large scale what areas have succeeded in achieving characteristics of transit-oriented development. In order to create a method for measurement a review of spatial analysis techniques was necessary to determine what methods and metrics are commonly used for measurement in this field. The wider area of study around spatial analysis defines many of the methods used within academic analyses of transit oriented or sprawled development typologies. While there are many ways to measure spatial characteristics, Reis (2016) succinctly identifies commonly used geospatial metrics often used to measure urban spatial patterns in research executed by urban planners. These metrics for spatial patterns are summarized below in Table 1.

Table 1 Commonly Used Geospatial Metrics by Category

Category	Meaning	Metrics	
Fragmentation	Considers the relation between built-up settlements or blocks and open areas. Measures the extent to which urban settlements are more continuous and concentrated or more scattered (fragmented)	Fractal dimension Index Clustering Ratio of Open Space Leapfrog Index Degree of sealing Gross Leapfrog Index Net Leapfrog Index Land Consumption Index Fraction of imperv. Surface Peripheral Density	Continuity Clustering Dispersion Index H Indicator Hrel Indicator Area Index Cluster Index Shape Index Compactness Coefficient of Variation
Density	Measures the density of built-up development, infrastructure, people or activities in an area, or the intensity of particular land uses	Population Density Residential Density Lot Size Floor Space Job Density Single Family Dwellings dens	Clark's dens. gradient Road network density Urban density index Ratio density of people Av. Household size Res dev. Existing UA
Land Use Diversity	Measures the relative distribution of different land uses	Segregated land use Land use diversity Land consumption index Land use diversity index Total Greenery Neighborhood rec. area	Mixed actual Mixed zoned Mixed Uses Mix Urb LU Change Area neighb. green
Centrality	Measures the relative position of settlements in relation to the whole urban area	Centrality index Index of remoteness Spatial isolation index Centralization index Nuclearity	Distance to CBD I Distance to CBD II Centrality Core-dominated nucl. H indicator Hrel indicator
Accessibility	Measure the spatial distribution of activities focusing on the proximity between land uses in an urban area	Commercial distance Commercial ped. Access. Bus distance Park distance Proximity (same LU) Proximity (Diff LU) Community node inaccess.	Med. Dist. to schools Transit ped. access Weighted av. proximity Dist. to roads Dist. to pr. school Dist. to shopping Degree of isolation
Connectivity	Measures the connectivity between different places in an urban community	Internal (street) connectivity External connectivity Blocks perimeter	Blocks Length cul-de-sacs Dendritic street pattern
Inequality	Measures inequality in the distribution of attributes	Concentration Delta Index	Relative entropy Batty's entropy
Spatial Network Analysis	Measures developed in space syntax or in related methods; Also uses dual graph but with a different method for construction of axial map; Uses a primal graph, more common in other spatial network analysis approaches	Integration Connectivity Mean depth Synergy Intelligibility Mean axial lines length Number of nodes Average degree Characteristic path length Closeness centrality Betweeness centrality	Number of axial lines Control Grid axiality Axial ringiness Real rel. asymmetry Choice Clustering coefficient Efficiency Straightness centrality Information centrality
Other Metrics	Metrics that quantify particular features of urban areas, not included in other categories	Highway strip index Median contour polycentricity Mean contour polycentricity Peak ratio Share of renovated houses	Res. Vacancy Orientation index Ratio A ratio Share of demolition

Each metric belongs to a different category of measurement with different meanings or goals. The metrics that will be discussed and used for this methodology are highlighted in blue for later reference.

As seen above there are a variety of different ways to measure spatial change, including how areas cluster around each other or do not, how accessible an area is or not, and how centrally located downtown areas are or are not. All of the studies referenced in the methodology section of this thesis use some collection of metrics from Table 1, focusing on the ones that best provide measurements that would answer the question they are asking.

Methodology: TOD Research Case Studies

Much of the early body of literature surrounding TOD focuses on the purpose of justifying the development type and measuring its success at achieving its purpose (Singh 2014). In 2008 Cervero and Murakami noted that density, land use diversity, urban design, destination accessibility and distance to transit were the most important measurements of successful TODs, and these have been the most frequently used measurements in the literature. All of these characteristics are not only part of TOD but necessary for it to succeed, as transit access alone does not achieve all the goals of TOD. Researchers are now focusing on finding ways to measure these additional characteristics to answer questions such as what areas show a propensity for TOD. Identification of characteristics of TOD and scoring areas on these characteristics is often used to identify municipalities with prime existing design to support long term TOD planning (Singh 2014).

A recent publication focused on transit-oriented development typologies in Brisbane,

Australia with respect to the lands' existing characteristics and its potential to support transit-oriented development. Brisbane has a long-term strategic vision to facilitate smart growth, decrease congestion, and cut carbon emissions in Queensland, and as such is looking to identify areas to implement sustainable development types. Multicriteria analysis was identified as a way to measure the potential by looking at the existing features of the land. The study used derived measurements of land use diversity, public transit accessibility, job density, and built environment indicators. With these factors a cluster analysis was executed in order to identify TOD clusters. The results indicated four types of TOD typologies in Brisbane, labeled as Clusters 1 through 4, with varying levels of TOD potential. Cluster 1 had the least potential for success if investment were to occur and Cluster 4 had the most potential for success if TOD were implemented (Kamruzzaman 2013).

Another study focused on a comparison between Washington D.C. and Baltimore on how travel behavior changes in TODs (Nasri 2014). The question being asked was whether TODs decreased car user ship. Steps taken to answer the question were first locating TODs using a multi-criteria analysis looking at walkability, density, walking distance to transit and mixed uses and then analyzing those areas within and outside of the TOD area. This method used the standard half-mile radius around transit that generally represents the one of development. The findings did confirm that TODs reduce car use and result in residents living overall more sustainable lives (Nasri 2014). From the criteria used in analysis it should be noted that not only transit, but density of intersections and increased walkability also contribute to reduction in car use, as opposed to presence of transit alone.

In addition to identifying locations prime for TOD, the literature has also begun advocating for developing TOD with the goal of adding in transit later. One particular article

states “TOD planning is not and should not only be about creating development that is oriented towards transit use. It should also mean bringing transit to those locations, where the development already possesses the physical characteristics of that of a typical TOD but without having transit connectivity at that place” (Singh 2014 pg 130). This concept is the crux of this research, taking the concept of TOD and flipping it, bringing transit to areas with TOD characteristics as opposed to only bringing characteristics into an area with existing transit. This particular article provides a case study of a spatial multicriteria analysis similar to the one to be executed for this research, focusing on the geography of the Netherlands and aiming to provide a TOD index to rank areas for their propensity to support TOD. Singh summarizes the findings by indicating that while they only used one index analysis, they support the use of two methods of analysis: one to measure propensity for TOD and one to measure actual existing TOD, an important distinction.

Singh’s analysis resulted in hot spots of development that lend themselves to recommendations of improved transit connectivity if they had ideal infrastructure but were more than 800 meters away from a transit node (Singh 2014).

Some writings have also encouraged planners and developers to put less emphasis on the transit aspect of transit-oriented development, and more on characteristics of density, diversity of land uses, walkability, connectivity, and housing typology (Chatman 2013). While transit is an important aspect of increasing sustainable lifestyles, recent literature indicates other factors are more important than the presence of rail transit, for achieving goals of decreased car ownership or use, improved community, and sustainable living. Recent suggestions by researchers have been made for municipalities to switch their focus from providing rail to providing all the other many characteristics that make up transit-oriented developments (Chatman 2013).

New Jersey's Transit Oriented Development History

The geography chosen for this analysis of transit-oriented development and associated policy implementation is a selected portion of Northern New Jersey. Not only has the state had a recent history of implementing transit-oriented development, but throughout the 1800s New Jersey's development was very much centered on the private rail lines which was the primary means of transportation at the time. This base of historical infrastructure and dense development lends itself well for an analysis of determining areas that have innate characteristics of TOD.

New Jersey began embracing the movement to urbanize and reverse the mid-20th century decline in public transportation use in 1986 when the state adopted a redevelopment plan in an effort to encourage growth around existing infrastructure. In 1992 the state began the Transit Friendly Planning Land Use and Development program to help municipalities develop around transit to provide guidance and technical assistance for TOD (Rinde 2015).

New Jersey's Transit Village Initiative began in 1999 as a follow up to the Transit Friendly Planning Land Use and Development program to provide assistance for townships that achieve the beginnings of TOD (NJ Department of Transportation). The program, spearheaded by New Jersey Department of Transportation (NJDOT) and NJ Transit, is meant to help townships financially and technically implement strategies in their areas and to encourage dense mixed-use development within a half-mile of a transit node. The program was started by then Governor Christie Whitman, and in the first year there were five municipalities designated (Rinde 2015). Currently the program has 33 designated municipalities, the most recently designated being Asbury Park, New Jersey in 2017 (NJ Department of Transportation).

The program has a Transit Village Task Force which is made up of statewide organizations which include Main Street New Jersey, New Jersey Council on the Arts, New Jersey Department of Community Affairs, New Jersey Department of Environmental Protection, New Jersey Housing and Mortgage Finance Agency, New Jersey Office of Smart Growth, New Jersey Redevelopment Authority and NJ Transit. Participating municipalities have the opportunity to coordinate with these agencies and receive priority funding, technical assistance, and grant eligibility (NJ Department of Transportation).

The Transit Village program has certain criteria municipalities must meet prior to applying for designation. These criteria are similar to many concepts outlined by the early TOD theorists and include compact traditional building and site design, high-quality walking and biking environments, mix of transit-supportive uses, attention to placemaking and the pedestrian realm, locating taller buildings close to transit stations and transit-supportive parking. The program indicates that the focus of development must be within a half mile radius of a transit station, which is a generally accepted radius for development in literature on the subject and correlates to about a 10-15-minute walk radius (Nasri 2014).

Early research on TOD often focused on measuring the benefits of TOD and how it has changed landscapes in the areas in which it has been implemented. The intent was to provide a base of research showing the beneficial impacts of TOD to justify its continued use. Regarding the New Jersey Transit Village program specifically, much analysis has been done to confirm the positive aspects of the program for its participants and assuage concerns of citizens. A 2010 report executed by Rutgers took a look at New Jersey Transit Villages and the impacts designation has had on them. The results of the report showed auto ownership was lower in smaller dwelling units, for example townhouses, apartments, and rental units (Chatman 2010).

The results of the study found a strong linkage between the presence of parking and auto commuting, noting that as public parking availability decreases it is less likely that people will drive to work. The report offered other data showing the positive benefits that density can provide and debunking concerns around ideas of overcrowded schools and parking impacts (Chatman 2010).

A separate analysis of New Jersey Transit Villages looked at specific municipalities as case studies and identified the benefits that each received from their efforts participating in TOD. This report took a very fine-grain look at just a few municipalities and offered a qualitative analysis consisting of interviews with local officials, residents, developers and businesses. This study noted economic growth, environmental benefits and health benefits for each municipality studied and also indicated that residents had a positive perception of the implementation of TOD in their towns. This study was one of the few that provided such a qualitative analysis of TOD implementation, looking at both the policy and the financial perspective of development (Noland 2014).

Research done on the Transit Village program is strong evidence of the positive long-term benefits of participating in the Transit Village program, but it should be noted that Transit Villages are almost exclusively centered on rail stations. Of the currently 33 designated towns two do not have a train station in its limits. Because of the limited Transit Villages not centered around rail, a lack of a rail station seems to be a barrier to entry into this particular program and the benefits it provides. This barrier may require towns to pursue sustainable development through other means, as opposed to implementing more extensive bus transit which would be a cheaper option to execute than introducing rail.

New Jersey as a state does provide other programs and grant opportunities from which to receive funds for development improvement outside of the Transit Village program, some being federal programs, but the Transit Village Program provides priority and greater opportunity.

Chapter 2: Research Question and Methodology

Research Question

The research looks at how important is transit to implementation of TOD development techniques. The question presented here is whether transportation presence is necessary to amplify and promote attributes of transit-oriented development and are there areas that have supporting characteristics which can implement TOD and bring in transit at a later date?

Proposed Methodology Overview

With the understanding of the Transit Village program supporting a central station focus and the literature pushing planners to think beyond the need for TOD to have major transit already in existence, this methodology provides analysis to look closer at typologies and townships that are successful, both designated and not, to identify similarities and differences in techniques and funding sources.

An important aspect of research regarding transit-oriented development is related to how it is defined. Its implementation and theorization has resulted in varied definitions based on different interpretations of the concept. Researchers and practitioners have generally two perspectives on defining TOD: one focusing on a combination of employment opportunities, retail, density of housing and walkability while the other focusing on the synergistic relationship between transit and land use policy (Nasri 2014).

The definition of TOD for the purposes of this research is one that focuses more on the integration of characteristics such as job density, land use diversity, housing density, and accessibility. The focus here is placed less on the transit as a central node and more on the development type that is supportive of implementing transit options.

Prior research indicated in the previous sections literature review has provided a foundation for identification of areas that may not have anchoring characteristics of a TOD, such as a major rail station, but would still benefit from other TOD characteristics such as increased walkability, higher densities, and increased mixed-use development resulting in greater job opportunities, with the possibility of bringing in transit at a later date. New Jersey, as the densest state in the United States, as well as having an extensive state-wide bus service and being located near two significant metropolitan areas is a prime case study for identifying these development types. Additionally, New Jersey has a strong history of rail that resulted in TOD typologies in areas that no longer have rail access.

The goal of the proposed methodology is to use the commonly used characteristics of TOD to identify high scoring areas, which would indicate potential for TOD. Depending on where these hot spots of TOD characteristics are located, it can then be identified what development trends, or geographical similarities there are for municipalities that are high scoring, for both municipalities that are Transit Village and not Transit Village designated.

Study Area

The study area for this project includes northern New Jersey counties centered on the New York metropolitan area through which NJ Transit Rail lines extend. This study area was chosen in order to allow for a focus on the New York Metropolitan area, and on NJ transit rail lines, as they are a sponsor of the Transit Village program. The study area along with the designated Transit Villages within the study area can be seen below in Figure 1.

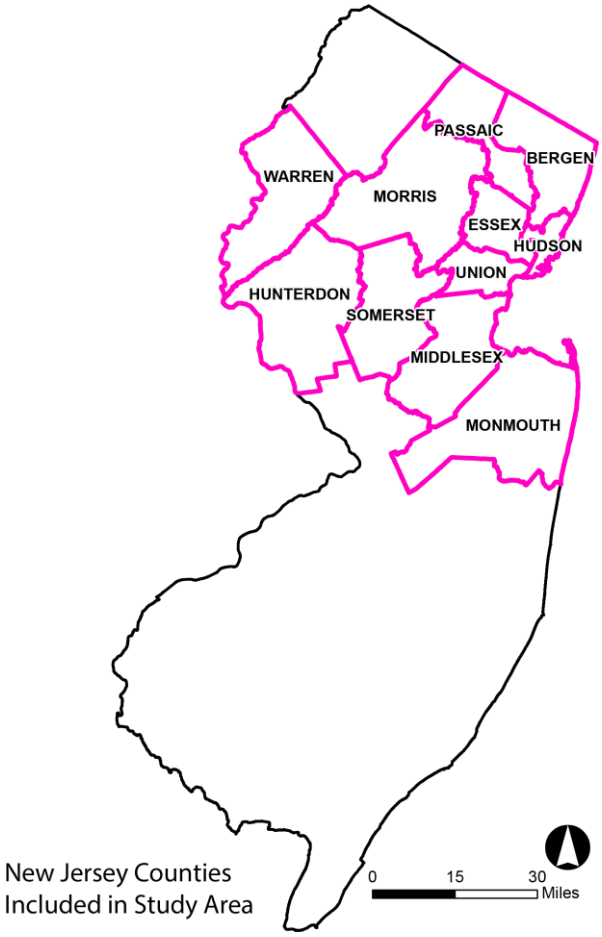

Figure 1. Identification of Study Area Municipalities

Counties included in the analysis are Warren, Hunterdon, Morris, Passaic, Bergen, Essex, Hudson, Union, Somerset, Middlesex, and Monmouth. These eleven counties have a mix of transit options which include NJ Transit Commuter Rail, NJ Transit Bus, NJ Transit Bergen Light Rail, and Path Service into New York City as well as ferry service along the Hudson River waterfront.

GIS Analysis Methods

A multi-criteria GIS analysis was executed in in order to identify areas with TOD characteristics as defined by the following methodology. This methodology has been designed to include metrics of the multi-criteria analysis precedents outlined in the literature review and are based on the generally accepted metrics for spatial analysis outlined previously.

There are be five factors included in the analysis, which are used to provide two index scores. The scores were calculated as values and aggregated to a cell within a grid covering the study area. The factors incorporated in the index scores are intersection density (NJ roads file – New Jersey Geographic Information Network), population density (US Census Data), job density (LODES Data), land use appropriateness (Land Cover - New Jersey Bureau of GIS), and transit stop density; bus and rail (NJ Transit Station Locations). These criteria are standard ways to measure characteristics of walkability, accessibility, and economic development (Singh 2014).

Transit density looks at all rail stops and bus stops within the geography and measure the density of transit nodes within the determined area. As transit is not the main focus of analysis this value will only be incorporated into one of the two index scores and used as a comparison for the non-transit index score.

Intersection density provides a measure of connectivity of an area. It is determined by generating nodes at intersection to allow for a calculation of intersections per aerial unit. This is a common measure of how connected an area is as higher intersection density provides shorter walk distances to destinations. The roadway network used for intersection analysis had highway routes removed from the data set, which is typical in TOD analyses when determining

walkability (Schlossberg 2004). This emphasizes the more walkable navigable local streets within municipalities, which are more amenable for TOD than major high-speed roadways.

Population density provides a measure of how built up an area is. It is calculated by taking the population by census tracts and normalizing by census tract area to provide a density measure, thereby showing how many people are living in close proximity to each other.

Job density provides a measure of economic vitality of an area, a common goal of transit-oriented development's being to provide jobs and economic growth. It is calculated using LEHD Origin-Destination Employment Statistics (LODES) data. Job location point values on the census block level from the On the Map interface were attributed to their original 2015 census block geography for use in the multi-criteria analysis.

Land use diversity provides a measure of ease of multi trips and land use type provides an idea of the level of development, for example mixed-use residential verses a rural single unit designation could indicate a town center verses low-density farm area. This is calculated by using the existing land cover shapefile provided by the New Jersey Bureau of GIS. The aggregated State-Wide land use file uses a system of land use assignment based on A Land Use and Land Cover Classification System for Use with Remote Sensor Data, U. S. Geological Survey Professional Paper 964, 1976. The current land use designation system contains over fifty separate categories, all included in Appendix A. Only twelve of the land use categories were deemed appropriate for TOD opportunity and weighted based on level of appropriateness. Land uses indicating higher density have higher weighted values, while lower appropriateness is indicated by lower values. The weighting system for each individual land use type is shown below in Table 2.

Table 2 Land Use Categorization

Urban 1000 Series		
1100		Residential
1110	0.9	High Density Multi Dwelling
1120	0.8	Single Unit Medium density
1150	1	Mixed Residential
1200	0.8	Commercial and services
1300	0.6	Industrial
1400	0.7	Transportation./Communication/Utilities
1420	0.7	Railroad Facilities
1500	0.8	Industrial and Commercial Complexes
1600	1	Mixed Urban or Built up
1700	0.8	Other Urban or Built-Up Land
1800	0.8	Recreational Area
1810	0.8	Stadium Theaters Cultural Centers and Zoos

Highest scoring land uses include the categories indicating a mix of land uses, mixed urban or built up and mixed residential. Mixed residential shows up in the strongest downtown areas where residential is generally located above retail or other use. Lower land use classes include transportation communication and utilities. In New Jersey these land uses are generally characterized by major highways and other non-stimulating uses. Land uses in-between are beneficial in some way and are thus given values as opposed to the zero value land uses included in the appendix.

The first index score calculated was Employment, Population, Land Use, Intersection, and Transit (EPLIT) and the second index score calculated was Employment Population Land Use and Intersection (EPLI). EPLI index score is the main focus of the research analysis and is the index used to analyze the municipalities within the study area.

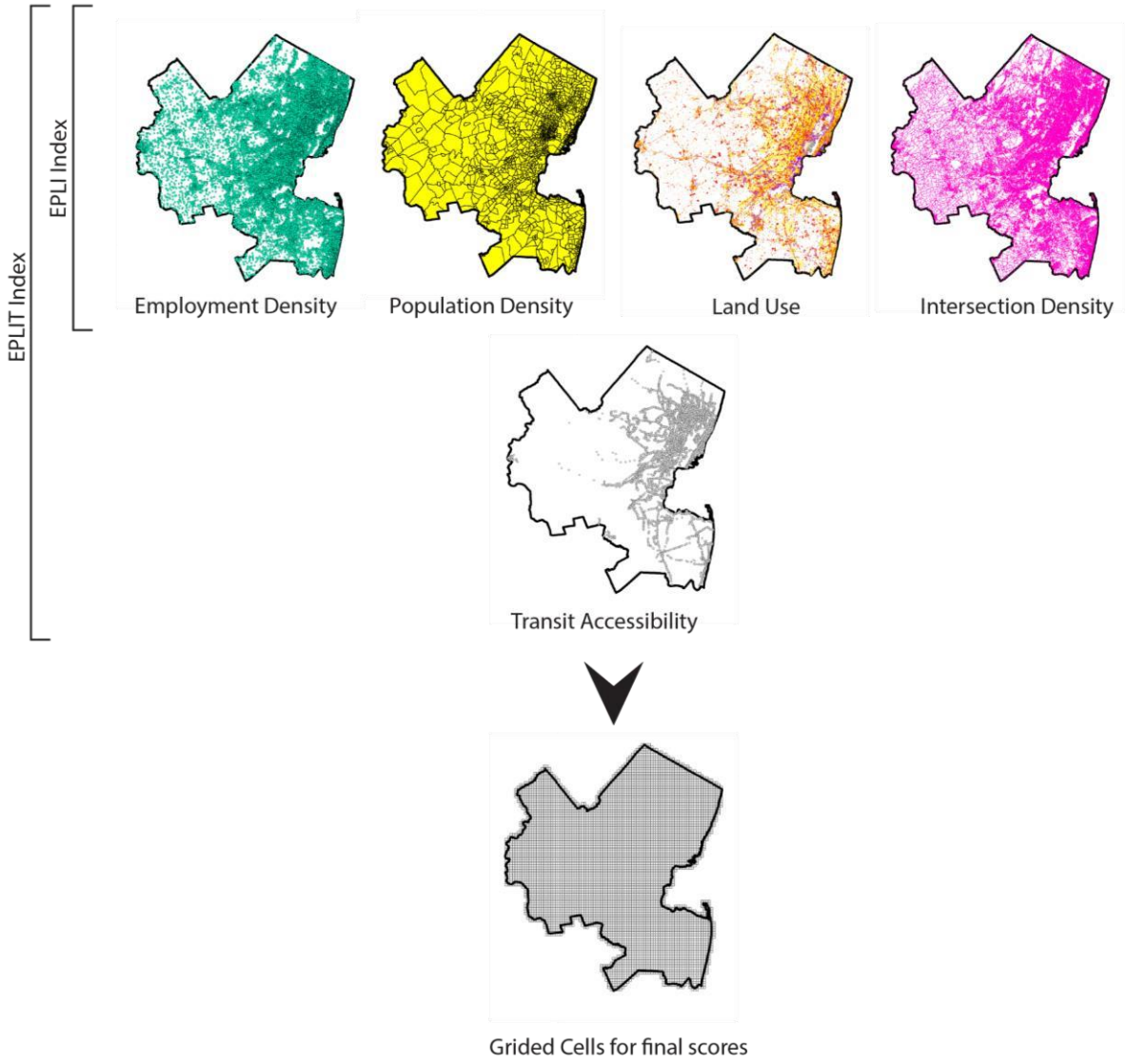

Figure 2. Index Score Factors for EPLI and EPLIT

Unit of Analysis

Transit-oriented development is generally defined within the literature as occurring within a certain radius of transit, generally a half-mile radius (Singh 2014). As mentioned previously, for consideration in New Jerseys' Transit Village Initiative municipalities are required to improve the area within that half-mile radius of their main transit stations. Because of this widely accepted unit measurement, a mile grid cell was a starting point for determining what an

appropriate grid cell size would be for the analysis. Two grid cell sizes were looked at for comparison, one-mile grid cell and a 0.707-mile grid cell. The one-mile grid cell which would encompass the entire one-mile radius circle, and a 0.707-mile square cell, which is the size of a square that would fit within a half mile radius circle.

In order to decide between the two a network analysis was performed on a typical transit oriented area assuming a distance of 0.5 miles. The resulting analysis shape, shown below in Figure 3, fit approximately the 0.707-mile square cell.

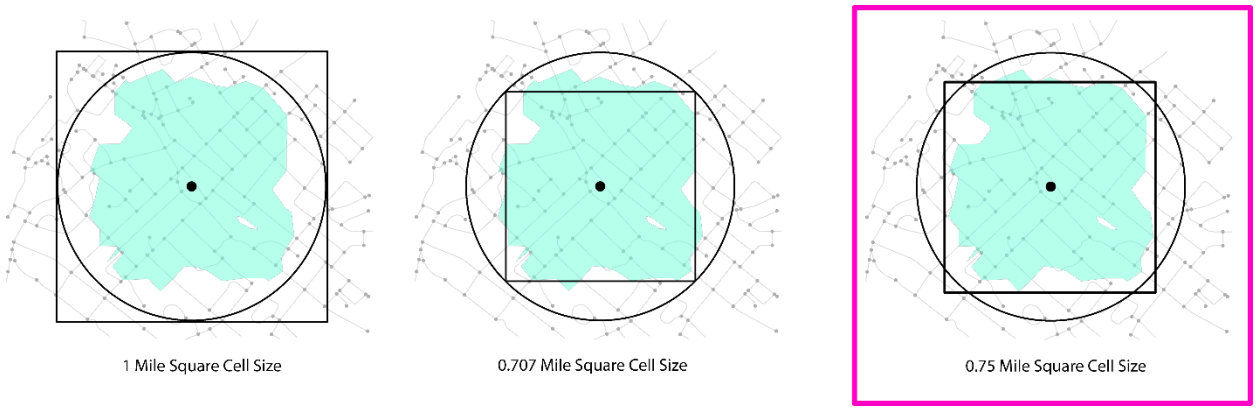

Figure 3. Cell Size Decision Process

The cell size decided on was a 0.75-mile grid cell this study's analysis, slightly larger than 0.707 but still approximately fitted to the walk analysis. This resulted in a consistent area of each cell of 15,681,600 square feet.

All metrics chosen for the Index value were normalized by their maximum value and thus individually range from 0-1. Land use was then weighted by 0.5, thus its score ranges from 0 to 0.5.

For the EPLIT index, the maximum score is 4.5, a maximum score of 1 for each Employment, Population, Intersection density, and Transit, and 0.5 maximum value for Land

Use. For EPLI the maximum score is 3.5, with the same logic of a maximum score of 1 for Employment, Population and Intersection density, and a maximum score of 0.5 for Land Use. Land use was weighted by 0.5 due to the volatility of the dataset. While land use such as retail and dense residential are important for TOD, limitations of the data set would identify a mall the same as a downtown retail store. For that reason it was included in the data set but in an effort not to skew scores based on unclear land classes it was weighted by 0.5

Qualitative Methodology

A second aspect of the methodology for TOD analysis is the interview and case study portion of the study. The above mentioned multi-county multi-criteria analysis results were anticipated to show a mapped indication of high scoring-municipalities. Based on the results of the TOD index analysis, municipalities were chosen for qualitative analysis, municipalities each designated and non-designated and of the non-designated, municipalities with and without extensive transit presence.

Qualitative review of the chosen case studies consisted of an overview of planning policy and development trends within the municipality. Review of these municipalities planning actions includes any zoning codes or zoning changes in recent years, economic development policy enactments, redevelopment plans, planning board meeting minutes if relevant, town masterplans, assistance program participation, and any plan analyzing the needs of the community and opportunities within the municipality.

Planning professionals from a municipality of each category would be contacted for interview. These planning professionals were to be contacted based on who is noted as the head of the planning department, or of redevelopment or an equivalent department. The goal of

including interviews in the methodology is to gain a first-hand account of what the municipality has done to achieve TOD characteristics or what redevelopment actions they have taken. The first-person perspectives would provide insight into the path of municipal development, such as identification of development types, land use types, walkability, and for the transit villages what assistance has the program has provided and what the designation process was like. Questions were tailored around whether the municipality was designated a Transit Village or not and are included in the appendix.

Comparisons will be made between the responses and between qualitative analysis of the towns to analyze the different ways they approach development. A goal for this portion of the research is to identify common ways for implementing transit-oriented development and creating walkable environments.

Chapter 3: Results

Results Summary

The results of the multi-criteria analysis showed some interesting region-wide trends of development as well as trends among municipality scores for Transit Villages and non-Transit Villages. Regionally, high scores were concentrated as expected mostly around transit, however there were some high scoring hotspots around abandoned rail stations. These results showed that old development typologies still effect the development of a municipality, lending to maintaining TOD characteristics even in the absence of transit.

An overall analysis of the scores also showed high scoring characteristics in many municipalities that either did not have transit or had transit and were not designated. The rankings of overall municipalities detailed in the full analysis show the strong potential of bus-centered Transit Villages as well as high scoring characteristics of non-designated municipalities, suggesting improvements could help these municipalities reach levels to support ridership in the future.

Findings

As noted in the methodology the initial score for municipalities included transit for a comparison of characteristics with and without transit. The intent behind including this initial base index score of EPLIT with transportation was to compare how the change altered the focus of municipal potential when looking at municipalities as having potential for transit as opposed to just having transit.

Shown below in Figures 4 and 5 are the resulting mapped scores for EPLIT and EPLI grids respectively.

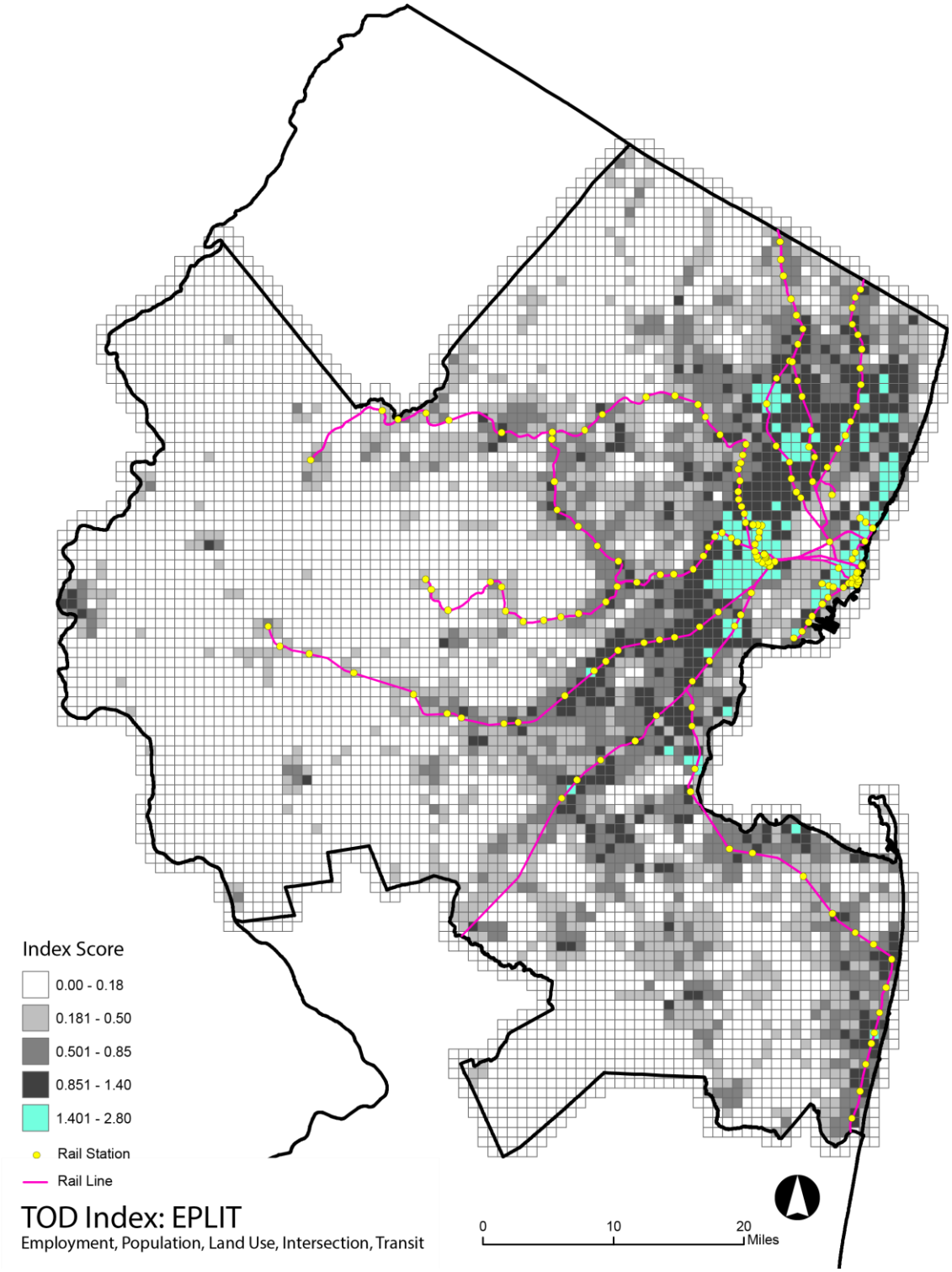

Figure 4. Index Scoring including Transit

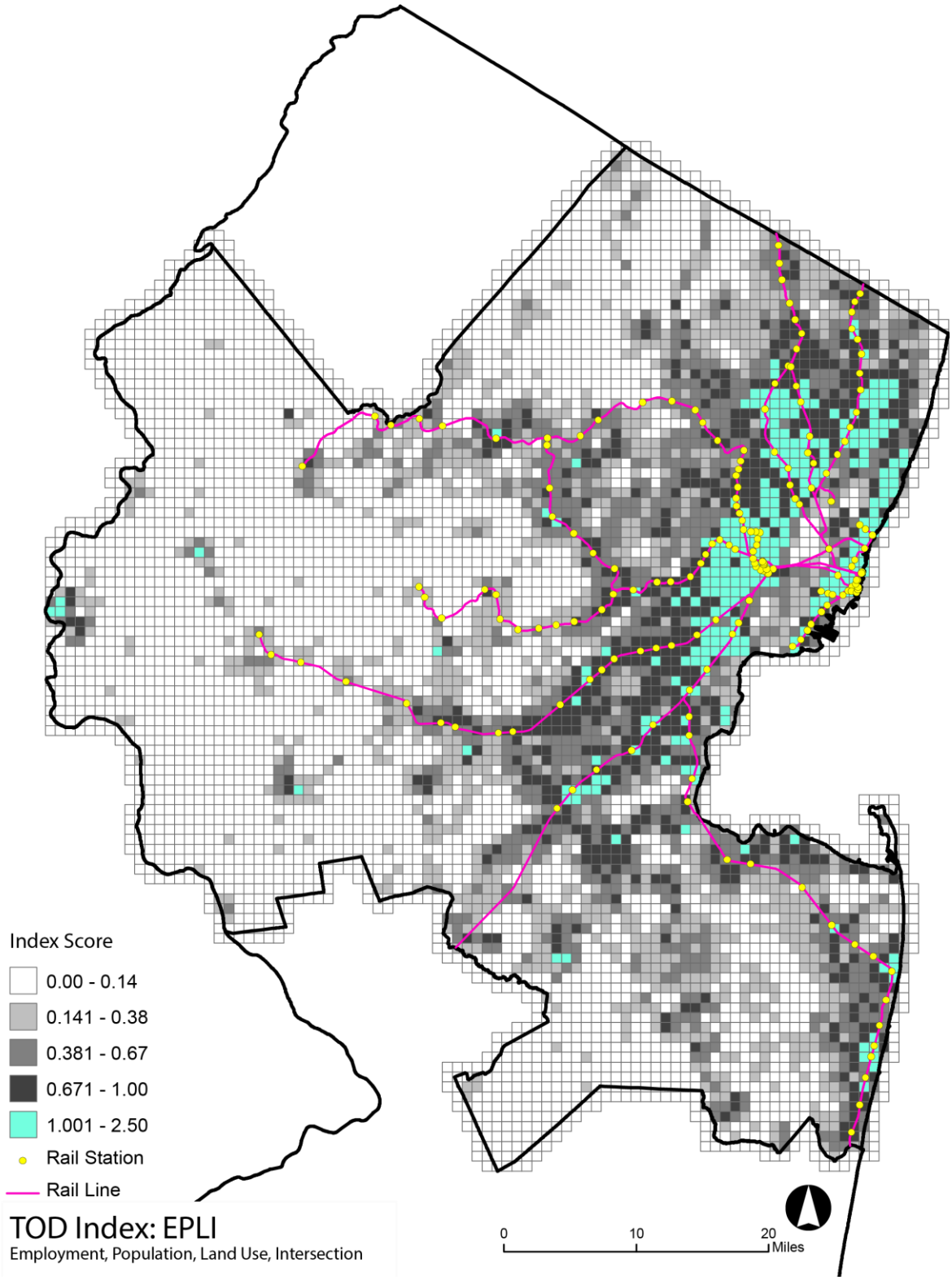

Figure 5. Main Index Score excluding Transit

From visual inspection it is clear that the high scoring municipalities are less concentrated around the rail lines in the resulting mapped EPLI index. Additionally, it shows high scoring areas that extend beyond existing rail lines, a characteristic that is diluted when the index includes transit. From a regional standpoint, this provides initial results showing that municipalities that are not connected to the initial network of rail and bus systems may show indications of walkable areas and are worthy of a closer look to determine what efforts have been or could be made on the ground level to leverage these scoring characteristics. These outliers also show potential for being integrated into the transit system at a later date with municipal drive and agency coordination if they were able to create enough demand for regional connections.

Regional Analysis

Prior to looking into the municipal level findings of the index results, a major finding in the results on a regional assessment of where high scoring municipalities are located was identified as the impact of historic rail on present day TOD characteristics. The highest scoring areas are concentrated around New York City as would be expected, as it is the densest area in the state. What was less anticipated is that some of the moderately to higher ranked municipalities in the EPLI index analysis are located along abandoned rail lines. Location of the high scoring areas indicated that to understand the potential of TOD one additional aspect for New Jersey specifically is to understand history of rail in the state.

Rail lines in New Jersey were once the main catalysts for development, prior to construction of major highways and the widespread use of the personal vehicle. Figure 6 below shows prior to the mid-19th century how extensive the rail tracks were in New Jersey, the mileage being over double what it is today (American Rails).

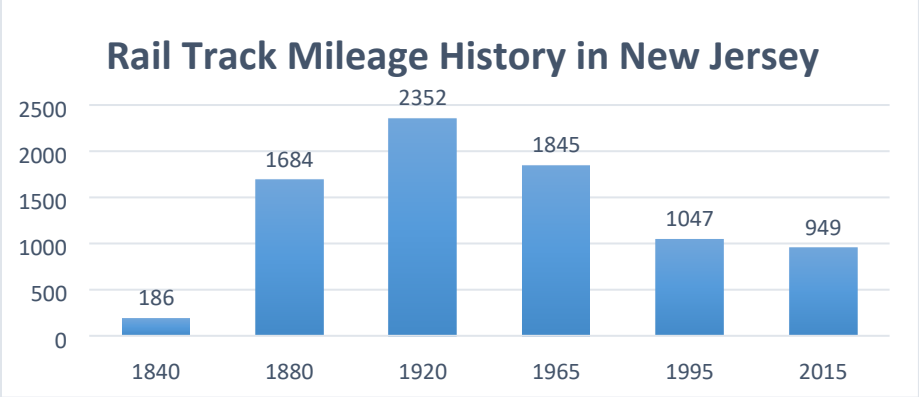

Figure 6. New Jersey Rail Mileage. Source: American-rails

As seen in Figure 6, in the 1800s significant construction of rail lines occurred in the State, with the trend tapering off after the 1920s, coinciding with more widespread use of the personal vehicle. In the 1800s, with extensive rail coverage and no personal vehicles for longer journeys, typical typology was denser and easier to traverse by foot. Development would concentrate around transit nodes to provide easier trips for residents and workers for daily activities (American Rails).

This denser development type can be seen in many of the older cities and towns in New Jersey such as Newark, Jersey City and Hoboken, all scoring in the top ten of the EPLI index score. While new development in undeveloped areas often follows the trend of transit-oriented development and denser construction, it is more difficult to change existing infrastructure such as street grids and building density. For these reasons, areas with a history of rail would often score high on aspects such as providing commercial land use downtown, higher intersection densities, and higher employment and population densities in downtown areas since they were created at a time when this type of infrastructural development was the norm. Some areas may have maintained these structural aspects better than others depending on ability to redevelop during

the height of suburban living, but the results and trends of high scoring cells show that many areas have kept the bones of their historic transit roots.

The high to mid-range scoring cells found dotted along historic rail lines can be matched in some areas to a map of rail lines in New Jersey from 1887, seen below in Figure 7. This map shows many historic lines, both freight and commuter, some which have gone unused for many decades.

Figure 7. Map of the rail roads of New Jersey 1887. Source: Library of Congress, Geography and Map Division

Counties such as Monmouth and Warren which today are extremely limited in transit service used to have a network of freight and commuter services previously offering much better regional access and potentially a contribution to their economies. Middlesex County is another

example of these historic trends. Though Middlesex does have some rail coverage today, historically it was much more connected in areas that have since gone underutilized by rail. Those areas that have retained the base characteristics measured in the index score as shown in the grid map. Figure 8 of the EPLI index with county outlines is shown below for context of these areas in comparison to the historic rail road lines.

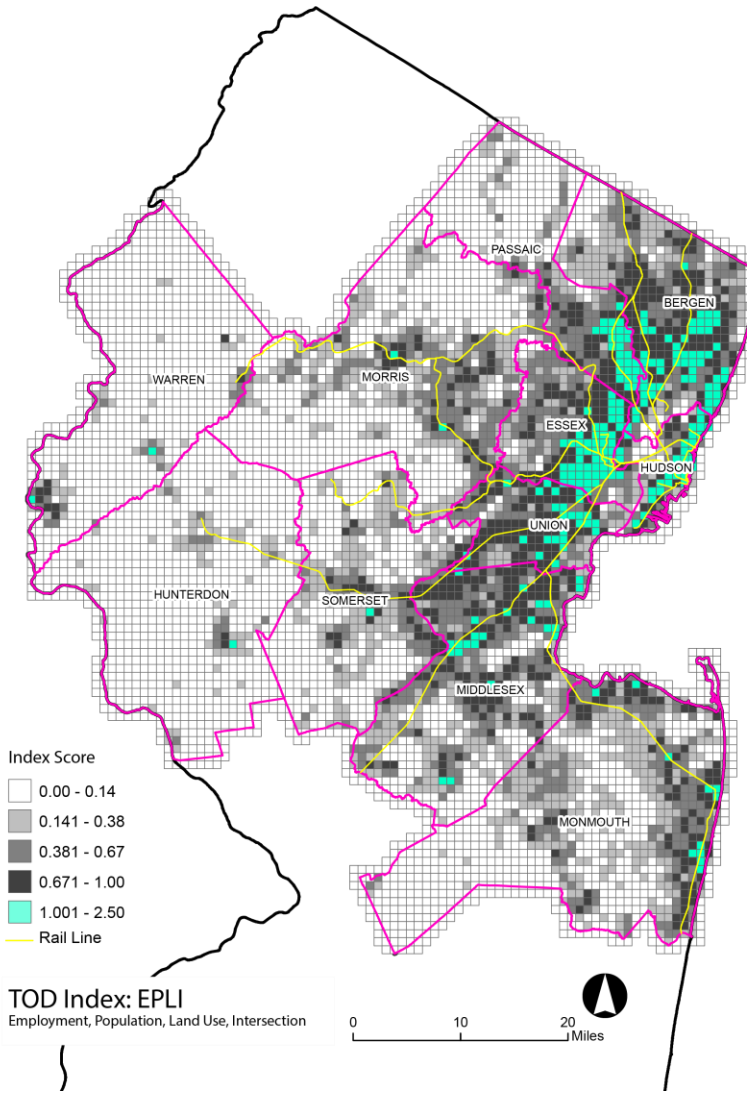

Figure 8. EPLI Index with Counties Overlaid

Looking forward to present day transit, NJ Transit has put forth efforts to develop new rail connections in dense parts of the state. NJ Transit has been putting together plans for

extending the Hudson-Bergen light rail, a 10-mile extension that will allow the Hudson-Bergen Line to finally connect into its partial namesake Hudson County. Figure 16 shows the current proposed alignment for the extension (Reitmeyer 2017).

Figure 9. Northern Branch Corridor. Credit: NJ Transit

The currently proposed extension would include seven new stations starting at the end of the existing light rail and ending at the Englewood Hospital and Medical Center. An additional light rail line proposal has been revived that has been titled the Passaic-Bergen Rail. This rail proposal re-uses existing abandoned rights of way and was initially put forth a decade ago. The

Passaic-Bergen rail proposal includes nine stations extending from Hackensack through Elmwood Park and Paterson to Hawthorne, all areas that scored high on the TOD index EPLI (Kofsky 2017).

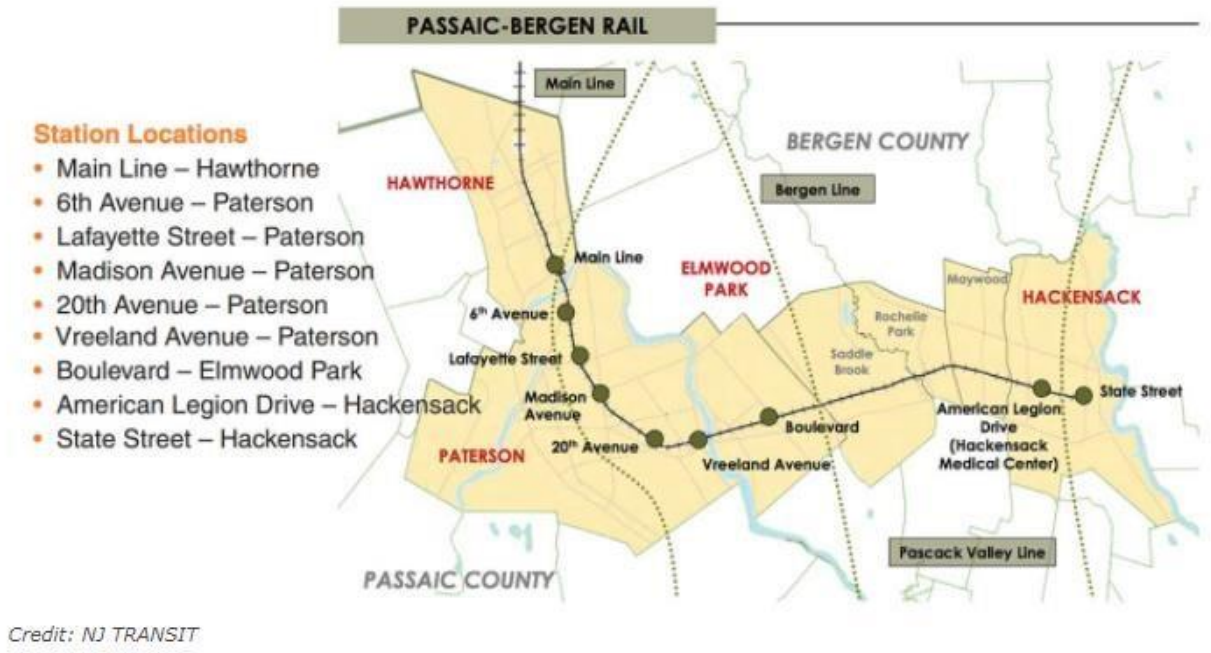

Figure 10. Passaic Bergen Rail Proposal

These efforts show that as a state New Jersey is executing good planning practice in reusing existing rights-of-way and targeting areas that have strong potential for transit-oriented development. These municipalities have existing characteristics of TOD and would benefit economically from increased access to and from their downtowns. The greater region would also likely experience decreased congestion as they would reduce the need for as many personal vehicles as exist now on the roads.

Analysis of Index Scores

A couple methods outlined below were used to compare Transit Villages, municipalities with rail, and non-designated municipalities to each other to determine differences in index scores. It was anticipated that the Transit Villages would score higher due to the municipal support and willingness, however the actual results were more complex and did not yield the anticipated results. Overall Transit Villages for top scoring municipalities and when compared with rail did not come out with higher scores than the other municipalities or other categories. The overall takeaway from the index score comparison is that many municipalities have characteristics of and therefore potential for TOD implementation outside of the Transit Village program, and in some cases outside of rail presence entirely. Detailed analysis is provided below.

The first method of comparison for the EPLI index scores was to look at the cells clustered around transit stations and Transit Villages to each other. The purpose of looking at the surrounding cells within a certain distance was to roughly determine ripple effects of development characteristics surrounding transit nodes.

Cells were selected based by location within a half-mile of transit nodes when analyzing Transit Village nodes and All Rail Station nodes. Categories for comparison included cell clusters for Transit Villages, cell clusters for all rail stations, and statistics for all cells in the grid. The distance of 2580 feet represents just under a half mile within the station, the generally accepted radius for TOD development around a station. The results of this comparison are shown below in Table 3.

Table 3. Score Comparison

	Transit Village	All Rail Stations	Overall Average
Number of Cells	116	601	6117
EPIL Score Low	0.082	0	0
EPIL Score High	2.015	2.42	2.42
EPIL Score Mean	0.947	0.767	0.265

A notable result from this comparison was that the Transit Village high score was lower than the rail station and overall average high score, 2.015 compared to 2.42. This could be an indicator of other rail stations and municipalities with potential for TOD outside of the existing designated municipalities, particularly as the highest overall score for all cells in the study is located in proximity to a rail station that is not designated.

The overall average score value for all cells in the grid covering the study area is much lower than the Transit Village average. This result is likely from inclusion of low density areas in municipalities without development or residents or forest and park land, which would contribute to zero values in the overall average. The All Rail Stations average is also lower than the Transit Village average, which may also indicate more suburban rail stations that lack commercial areas and dense development, possibly indicating presence of park and ride stations in more suburban municipalities or stations with less frequent service.

After this proximity comparison of cell scores, each municipality was categorized based on the attributes that this research focuses on most closely. It was determined that the four categories were Transit Village Designated Rail, Transit Village Designated Bus, Municipalities with Rail, and Not Designated municipalities. Each municipality was given one of the four categories to compare scores of each type. In order to identify a single score in relation to each

municipality, scores chosen were the single cell that represents the maximum value within that municipality. These maximum cell values were selected and attributed to the municipality geometry to allow for a single score for comparison representing the best attributes of the municipality.

In addition to categorizing the municipalities for comparison a threshold level was chosen to separate top municipalities from the rest in order to compare top scoring municipalities in different categories. The limit for top municipalities was chosen at municipality number 92, Dover New Jersey, which had a score of 1.174. This was chosen to be the limit as municipalities below this level that were not designated started to become more suburban. Dover and above appeared to have differences in typology, and it was important to compare high scoring municipalities to other high scoring municipalities to identify trends without including low scoring outliers. The summary of these top 92 categorized in the four chosen typologies is shown in Table 4.

Table 4. Top 92 Municipality Scores organized by category

	Rail	Rail Transit Village	Bus Transit Village	Not Designated
Count of Municipalities	28	15	2	47
Land Use Average	0.933	0.930	0.918	0.906
Employment Density Average	0.228	0.224	0.184	0.146
Population Density Average	0.359	0.300	0.343	0.255
Intersection average	0.690	0.569	0.648	0.661
Average Max Score EPLI	1.561	1.388	1.489	1.400

Of the four categories, the Rail (not designated) category had the highest overall EPLI index score, while Rail Transit Village had the lowest overall index score at 1.388. Due to the support outlined in the Transit Village program and the requirements municipalities needed to

execute to become involved in the program, it was expected that these municipalities would have higher scores which was not the case. The overall results of all 327 municipalities show that only two Transit Village designated towns are within the top twenty, Jersey City (5) and New Brunswick (19). When looking at the top scoring 92 municipalities the Rail Designated municipalities do fall short of standing out in achieving the high scores expected. A potential reason for all rail to have a higher average score than designated rail stations could be that the very high scoring municipalities are not looking for designation as their characteristics are strong enough not to need the assistance the program provides. If a municipality was experiencing successful development, their professionals might have determined that their efforts should focus on other grants or opportunities as opposed to spending efforts on designation.

Bus Transit Villages had 0.1 higher average than Rail Transit Villages at 1.489. Although there are only two bus Transit Villages indicating a small sample size, this indicates strong TOD typologies from the municipalities where Bus Stations received designation. Non-designated bus stations were not used in this comparison due to there not being separate data points for specific stations verses bus stops in New Jersey.

Not designated municipalities scored similarly to Rail Transit Villages at 1.400, indicating minimal difference in the top 92 municipality's characteristics of the index measurement between Transit Village rail and undesignated unanchored municipalities.

For comparison, all municipalities were categorized and averaged, shown in Table 5 below.

Table 5. Breakdown of Overall Averages including 327 Municipalities

	Rail	Rail Transit Village	Bus Transit Village	Not Designated
Count of Municipalities	85	26[1]	2	214
Land Use Average	0.772	0.872	0.918	0.688
Employment Density Average	0.133	0.175	0.184	0.076
Population Density Average	0.167	0.215	0.343	0.103
Intersection average	0.481	0.516	0.648	0.437
Average Overall Score EPLI	1.042	1.199	1.489	0.887

In the above overall comparison Bus Transit Village had the highest scores, but also the smallest sample size to choose from making it more difficult for comparison. Overall, Not designated municipalities had the lowest score, as this category included many suburban municipalities with rural residences and no propensity for transit-oriented development. These low or zero values likely brought down the overall average for that category. It is here that the overall breakdown that Rail Transit Village does have a higher average score than rail and not designated, scoring 1.199 verses 1.042 and 0.887.

Comparison of Transit Village Scores

Shown below in Figure 11 are the Transit Villages within the study area. The study area encompasses 27 of the 33 Transit Villages in the state. As noted in the previous section, the Transit Villages did not score significantly higher in the index than rail municipalities or undesignated and those not served by rail. Other comparisons to be looked at are within the

[1] The number of rail Transit Village designations in the study area is 25, with 2 bus Transit Village designations, the total of all Transit Villages being 27. The breakdown includes 26 Transit Villages because Rutherford is located at the boarder of East Rutherford and Rutherford, thus to include municipalities effected by the half mile radius both were included in Rail Transit Village for purposes of the max cell analysis.

Transit Villages themselves, whether year designated effects average score and how overall Transit Villages ranked compared to other municipalities.

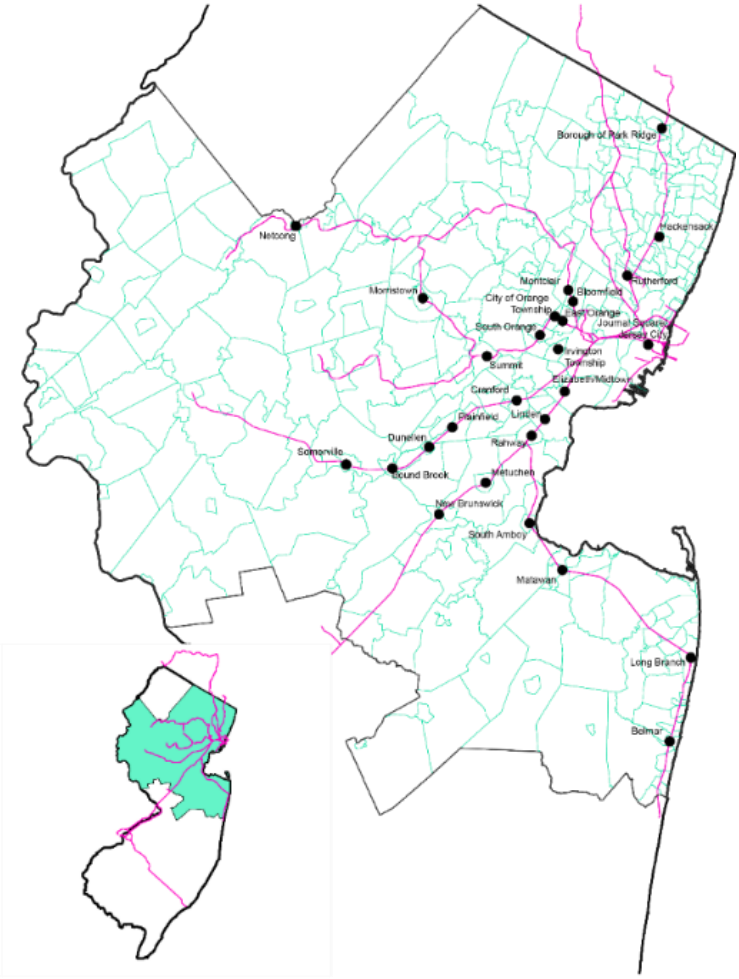

Figure 11. Study Area with Transit Village Locations

In order to better understand Transit Village characteristics and possible effects of municipal and state investment, these municipalities were looked at in comparison to each other as well as compared to all municipalities.

Data collection of the Transit Village scores, summarized in Table 6 below, were selected by creating a 0.5-mile buffer around the Transit Villages and selecting the maximum of the

surrounding cells. The maximum value was then spatially joined to the buffer to give the maximum cell score for that 0.5-mile area, which is the specific area which receives Transit Village designation. These maximum scores being within this radius should accurately represent the area of the Transit Village as designated by the Transit Village Initiative. As noted in the methodology description this was different than how municipal scores were determined in joining maximum values to all counties within the study area, as such this may provide higher or lower scores as the half mile radius may not reach the maximum scoring cell in the municipality, or it may reach a high scoring cell located in the neighboring municipality. The previously scored municipality ranked index has been included in this table for comparison.

Table 6. Transit Village Maximum Scores

Transit Village	**Station**	**Year Designated**	**Max Index TV**	***Max Index Muni***
Journal Square/Jersey City	Journal Square	2005	2.016	*2.091*
New Brunswick	New Brunswick	2005	1.614	*1.614*
Irvington Township	Irvington Bus Terminal	2015	1.501	*1.501*
Hackensack	Hackensack Bus Terminal	2016	1.478	*1.478*
Elizabeth/Midtown	Elizabeth	2007	1.444	*1.444*
Linden	Linden	2010	1.385	*1.385*
East Orange	Brick Church	2012	1.323	*1.413*
City of Orange Township	Orange	2009	1.323	*1.323*
Plainfield	Plainfield	2014	1.291	*1.291*
Montclair	Bay Street	2010	1.261	*1.261*
Morristown	Morristown	1999	1.237	*1.237*
Rutherford	Rutherford	1999	1.222	*1.243*
Summit	Summit	2013	1.212	*1.212*
Long Branch	Long Branch	2016	1.206	*1.206*
Bloomfield	Bloomfield	2003	1.13	*1.311*
Metuchen	Metuchen	2003	1.126	*1.126*
Rahway	Rahway	2002	1.101	*1.111*
South Orange	South Orange	1999	1.086	*1.4*

Belmar	Belmar	2003	1	*1.105*
Cranford	Cranford	2003	0.981	*1.165*
South Amboy	South Amboy	1999	0.958	*0.957*
Bound Brook	Bound Brook	2003	0.897	*0.891*
Somerville	Somerville	2010	0.888	*0.888*
Dunellen	Dunellen	2012	0.859	*0.859*
Borough of Park Ridge	Park Ridge	2015	0.85	*0.85*
Matawan	Aberdeen-Matawan	2003	0.833	*0.765*
Netcong	Netcong	2005	0.627	*0.627*

The majority of Transit Villages' half-mile areas remained mostly consistent with their municipality's scores, if they are off most are only slightly indicating consistent characteristics throughout the municipality. The matching scores between the municipality and the half-mile radius also indicate that the municipality is appropriately centering its development on the transit node as would be expected. Some inconsistencies can be seen in South Orange, East Orange, Cranford, and Bloomfield, where their highest scoring areas are not located within the half-mile radius of the transit station. This could be due to the municipality's location in urban areas and overflow of neighboring characteristics into their municipality, influencing maximum scored areas, though the center of development for that municipality may still be located around transit. The lack of matching scores could also be showing a shifted center of focus away from the transit node and may indicate a development center adjacent to transit but not the transit itself.

The line in Table 6 is included to show all the Transit Village half-mile area scores that were below the cut off for the top 92 municipalities used in the previous score comparison method. While most municipalities are located above the line it is notable that thirteen municipalities did not achieve scores high enough to be included in the narrowed focus area. Transit Villages of Matawan and Netcong had scores low enough for them to rank 232 and 263 of overall municipalities, with scores similar to municipalities such as Franklin Lakes,

Rockaway, Kinnelon and Riverdale, generally understood to be suburban residential municipalities.

It was predicted that Transit Villages designated earlier would have more time to work on implementing TOD in their area, resulting in higher scorers on the TOD index. To determine whether this was true, the year of the Transit Village and its designation value were mapped to determine if a trend existed. As can be seen in Figure 12 this was not the case, and there was no trend to be found between designation years and Transit Village score.

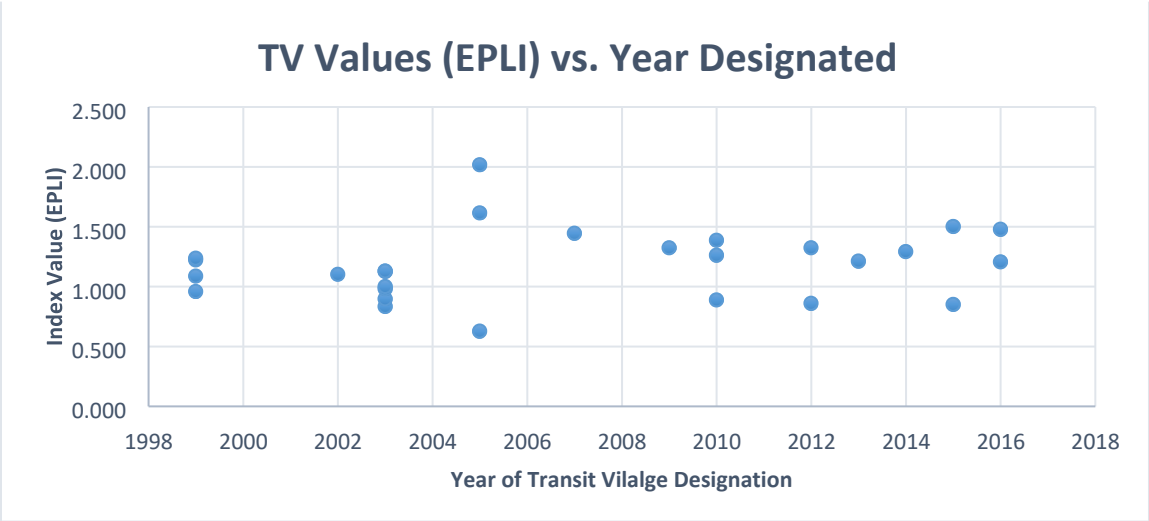

Figure 12. Transit Village Designation Year vs. Index Value

This lack of association between year designated and score could be an indicator of many different trends specific to the particular municipalities. One attribute may be due to government or public drive for implementation of TOD. If only minor policy changes had been made since designation it is unlikely that their town would have improved significantly from designation. Another possible reason for no time associated changes is that the index may be better for measuring base propensity for TOD and less accurate for changes made to municipality. For example, an attribute such as intersection density is unlikely to change significantly based on

development changes since changes in road layout are costlier and are unusual in existing towns. Additionally, population is relative to location within the state, as a high population for an area in Hudson County would not be as achievable in a municipality in Morris County, causing municipalities to show fewer trends in relation to each other as they would in relation to themselves over time.

Chapter 4: Case Studies

In order to get a closer look at what municipalities were showing up as having characteristics of TOD, municipalities of each of the categories identified in the previous section were looked at, bus centered Transit Village, rail centered Transit Village, rail not designated high scoring, and not designated high scoring. All municipalities used as case studies were among the top 92 used for comparison in the Index score analysis. All of the municipalities have very unique, location specific attributes and characteristics that can help or hinder their progress. Some of these may be existing infrastructure such as roadways, railways, industry development or geological attributes such as rivers or parklands. Municipalities may also have a population strongly in favor or against TOD that has influenced the rate of development or extent of development. An important aspect of this research is to look at ground level what municipalities have been focusing on to achieve more walkable accessible downtowns and attract developers and what specific features contribute to the character of their town.

Figure 13 shows the locations of the four municipalities chosen for further analysis. These were chosen based on score, location, categorization, and public perception from development trends and news articles. The following analysis looks at what planning work the town has been focused on in recent years, collects a table of recent planning documents related to these efforts, and reviews interviews with professionals from municipalities which responded.

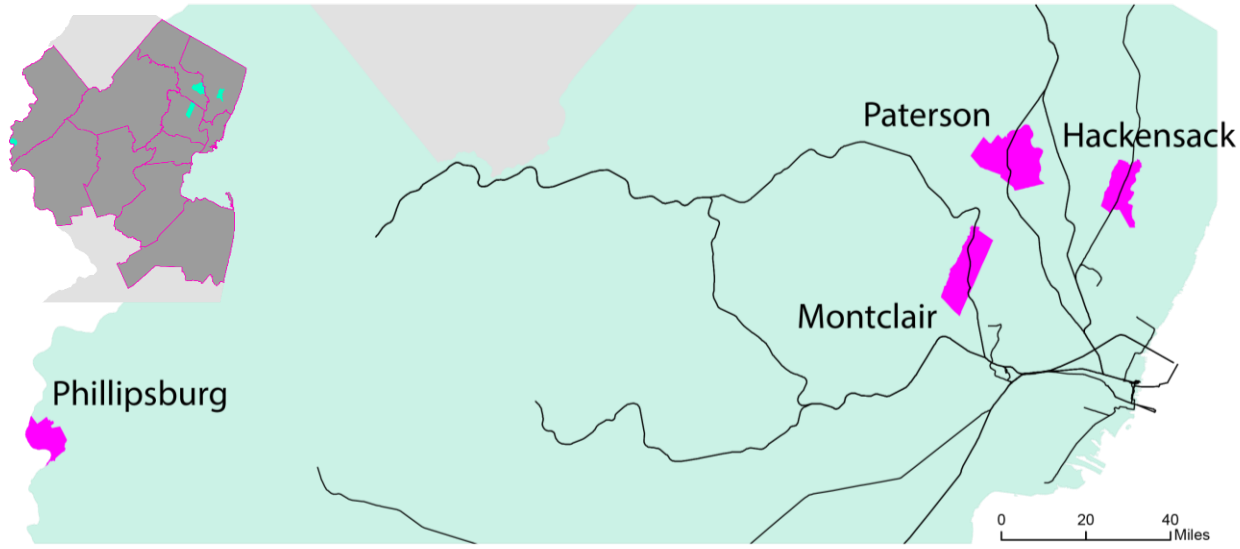

Figure 13. Case Study Municipalities Location Map

Phillipsburg, NJ - Not Designated

Phillipsburg, New Jersey, is located at the border of New Jersey and Pennsylvania in Warren County. In the EPLI Index, Phillipsburg was in the top third of municipalities with a score of 1.196, coming in at 88th of the 327 municipalities included in the study. Analyzing the results of the transit index, it stood out among the municipalities in the rankings as it was not in close proximity to the New York Metro area and did not have an operational transit station. Phillipsburg was incorporated as a township in 1851. Prior to it being a township Phillipsburg was the site of the Indian village Chintewink, and was known as a village long before it became Phillipsburg. Today Phillipsburg has a population of approximately 14,950 and has an area of 3.3 miles (2010 Census).

This case study relates to the previous discussion of historic rail infrastructure. Though Phillipsburg does not have a functioning commuter rail line, it does have an inactive railroad station, the Phillipsburg Union Station. This municipality was historically a major transportation hub and the location of convergence for the Central Railroad of New Jersey, the Morris and Essex Railroad, the Lehigh and Hudson River Railroad, Lehigh Valley Railroad, and the Pennsylvania Railroad's Belvidere Delaware Railroad. The historic town has a strong history tied to rail, the Morris Canal and its position in the Lehigh Valley that strongly influenced its early development. Today, Phillipsburg's neighbors include the major institutional presence of Lafayette College and the character filled town of Easton, Pennsylvania both just across the Delaware River.

Despite its history in rail, public transit is minimal in Phillipsburg. In 2010 NJ transit considered terminating service to the municipality entirely, but instead opted to limit the schedule but keep the bus lines (Wichert 2010). Today the township is served by bus lines 890 and 891 but has limited transit ridership as most people commute by car or other means.

The town has recently been putting together efforts and visioning meetings to position itself as a regional destination. From their planning documents, and most recently their land use plan presentation they intend to rethink their parking, land uses, and streetscapes, incorporating mixed use developments and establishing trails along the Delaware River. The historic rail infrastructure will be reused in a tourist capacity to attract visitors and the town has goals to revitalize the waterfront similar to how New York has revitalized parts of the Manhattan and Brooklyn waterfronts. One of the most recent visioning plans for the municipality focuses on a design charrette for redevelopment of the waterfront, which is one of the most walkable character

filled areas in the town. This shows how the township is beginning to redevelop in areas that have pre-identified potential to support their vision.

In moving forward with its redevelopment, its land use and masterplans have incorporated New Jersey's strategic plans, the highlands regional master plan, Warren County's plan, Pohatcong Township and Lopatcong Townships plans. In master planning it is important to integrate into the region, something Phillipsburg has clearly taken into account and considered by indicating a review of wider scope strategic plans.

Below in Table 7 is a brief outline of some of the recent planning documents that have been executed over the years to update the town's development trends to more accurately tend to the needed development types for the towns growth.

Table 7. Redevelopment Plans for Phillipsburg

Document Type	Year of Report / Presentation / Proposal
Master Plan	1988
Master Plan Reexamination Report	1996
Vision for South Main Street	1998
Redevelopment Plan for Delaware River	1999
Master Plan	2004
Mater Plan Revision	2013
HP Element Presentation	2016
Land Use Plan Presentation	2017

The draft goal statement Phillipsburg outlined in 2015 is as follows:

> To maintain the Town of Phillipsburg as a proud community where people and families of all ages and incomes can live and travel safely, have clean and well-kept neighborhoods, have a variety of above average housing opportunities and have accessibility to needed business and professional services. The community should preserve its history, protect its natural resources, provide recreation for all ages, and

> maintain a mixture of land uses that will offer a stable tax base (Town of Phillipsburg Land Use Plan, pg 4).

As seen in the goal statement, Phillipsburg's focus is strongly on economic growth and development types that support community growth and engagement. These goals and the tactics to achieve them outlined through masterplans and presentations put out by the town align with commonly outlined goals and techniques used in transit-oriented development and detailed by Calthorpe, which has the focus not only to increase transit usage but also to create community and economic development.

In addition to policy implementation, the towns land use was mapped below in Figure 14 to observe what the existing land use conditions are in Phillipsburg.

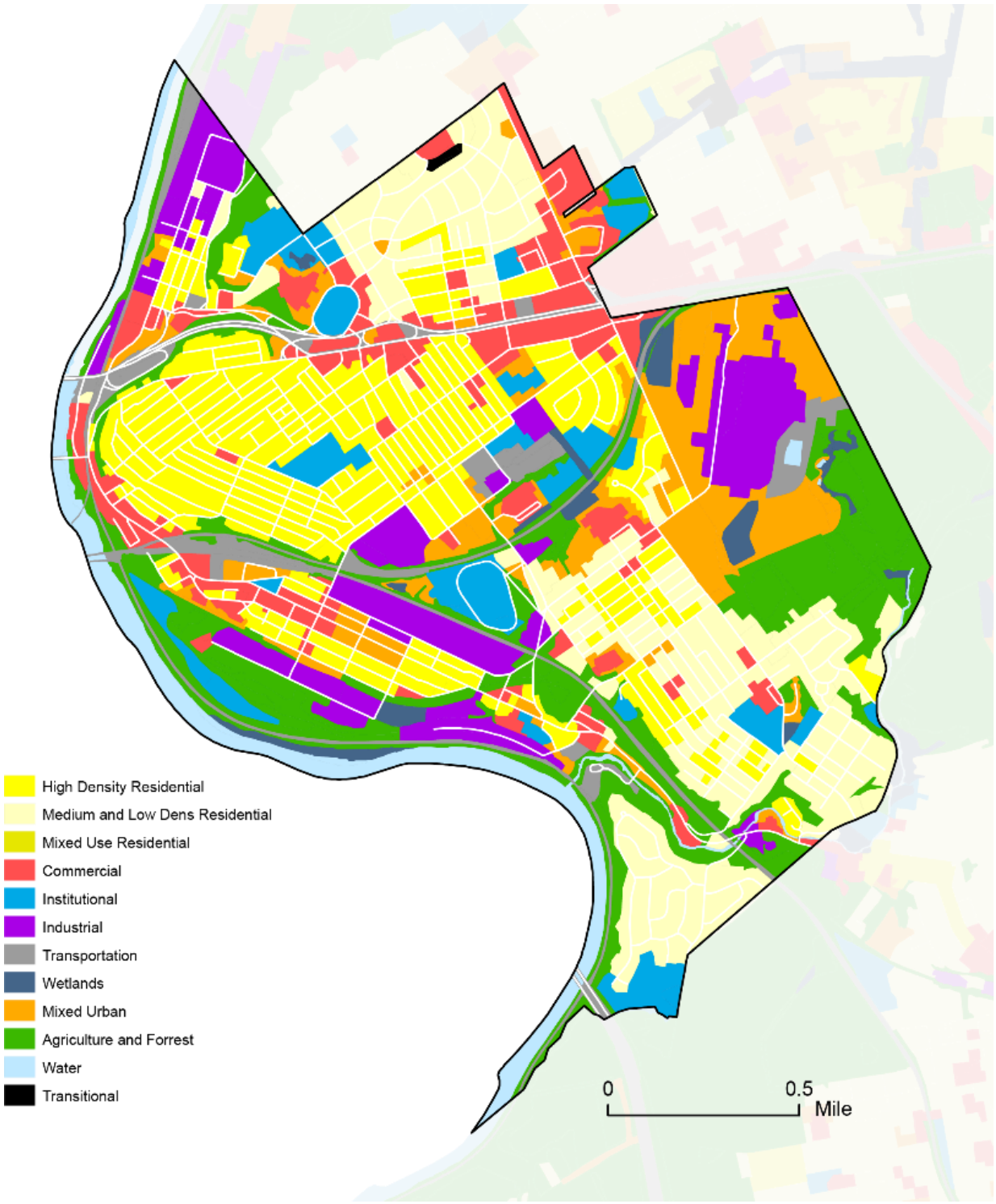

Figure 14. Phillipsburg Land Use Map

The waterfront, a current focus of redevelopment, has a strong commercial presence, high density residential and some mixed urban land uses. There is also commercial land along the

Route 22 (Memorial Parkway) to the north and North West which is more car oriented than the waterfront. The transition from dense development to more suburban can be seen by the residential land use becoming lighter further out indicating low density residential.

Phillipsburg is unique in being connected to a strong urban history but surrounded by a rural region. Moving forward this municipality is looking at diversity of uses, creating design guidelines, and creating a vision for the very suburban Route 22 (Memorial Parkway) running east west at the top of the town.

The plans and goals outlined here show that Phillipsburg has clearly identified its goals and is moving forward with executing development in a way that fits well with TOD trends but does not yet have an anchoring transit node. Over time as Phillipsburg provides economic vitality and diverse housing opportunities it could be an option for the town to move towards incorporating transit more as demand for access increases, something that could be taken into account and planned for now.

Hackensack – Bus Transit Village

Hackensack is one of the most recently designated Transit Villages having received designation at the end of 2015 with the official announcement in February of 2016. This designation was placed on the Hackensack Bus Terminal, the nearest transit node to the town's Main Street, making Hackensack one of three municipalities with designation surrounding a Bus Terminal. As one of the more recently designated municipalities this case study's focus is more centered on the path to designation and the town's efforts rather than the effects of designation.

Hackensack as a municipality has a population of 44,756 and is 4.346 square miles (U.S. Census). Hackensack also has three major transit nodes within its limits, two rail stations in

addition to its bus terminal. The municipality's Director of Redevelopment, Albert Dib, was contacted, agreed to be interviewed and discuss Hackensack's redevelopment and their transit-oriented development goals.

Hackensack's redevelopment plans over the last couple decades have focused on revitalizing the community in the wake of difficult economic years for the municipality. Hackensack's progression to coming upon the Transit Village designation was a result of their efforts to create a more walkable transit-oriented township. Over the years Hackensack has worked with developers and strategically chosen development types that fit within the vision for the township and has reaped the benefits by attracting developers and decreasing parking ratios, something often difficult to implement in towns looking to reduce focus on the personal vehicle. According to Dib, the municipality has parking ratios close to 1.1 spaces per unit, a significant decrease from 1.8 per unit prior redevelopment and new regulations. It was also mentioned that through the planning process many professionals noted how fortunate Hackensack is to have good "bones" for this form of development, a factor that can be attributed to the lack of development in Hackensack when other municipalities were building suburban type shopping centers and increasing parking lots. This preserved the original dense walkable network and their street wall on their main street. Throughout the development process Mr. Dib noted it was necessary at times to turn away developers if their proposal did not fit with the transit-oriented development standards the town aims to abide by, for example saying no to a chain developer because of their requirement for a drive thru, which does not contribute to walkable downtown areas.

The recommendation of designation came from a transit-oriented development report produced by New Jersey Institute of technology (NJIT) and North Jersey Transportation

Planning Authority (NJTPA). The report looked at all three transit nodes in Hackensack, the Anderson Street Station, Essex Street Station, and downtown bus terminal as the potential transit-oriented development zones. The report itself was a result of Hackensack's many year focus of improving the community through TOD and is one of many planning documents the town has put together to organize its efforts and engagement in the process. A table of some of these documents can be seen below.

Table 8. Planning Documents for Paterson

Plan	Year
Downtown Parking System Review	January 18, 2013
Transit Oriented Development Report	Spring 2013
Parking Development Presentation	September 2nd, 2014
City of Hackensack Rehabilitation Plan	Amended November 2015

The report begins with making comparisons to successful Transit Villages such as Morristown and New Brunswick and one of the final recommendations of the report is for the municipality to apply for designation. Shortly after the report, this the municipality began applying for designation, which was a two-year process, and received designation in late 2015.

From discussions with Mr. Dib, the designation was a long back and forth process. Discussions with NJ Transit, an analysis of their township and where development was focusing led them to designate the Bus Terminal over the two rail stations in town. Reasons for this included the extent of service bus transportation provides throughout the state and the benefits regionally of this access, noting the ease of getting in and out of the city made possible by bus only lanes and frequent service. The location of the bus station itself also fit well with the towns goals of focusing on downtown as the bus station is more centrally located than the two rail

stations and the half mile radius outlined in the Transit Village requirements encompasses the main street area and new performing arts center.

Mr. Dib indicated that it has been too recent to determine what the final outcomes and assistance may be of the Transit Village designation. Transit Village benefits such as grant eligibility to help fund their existing initiatives and possibly fund bike share as well as infrastructure loans with attractive interest rates were some potential benefits mentioned that would help Hackensack achieve their goals moving forward. Mr. Dib notes that the designation was a municipality driven process, and that residents may not be entirely familiar with the designation or the development typology specifics.

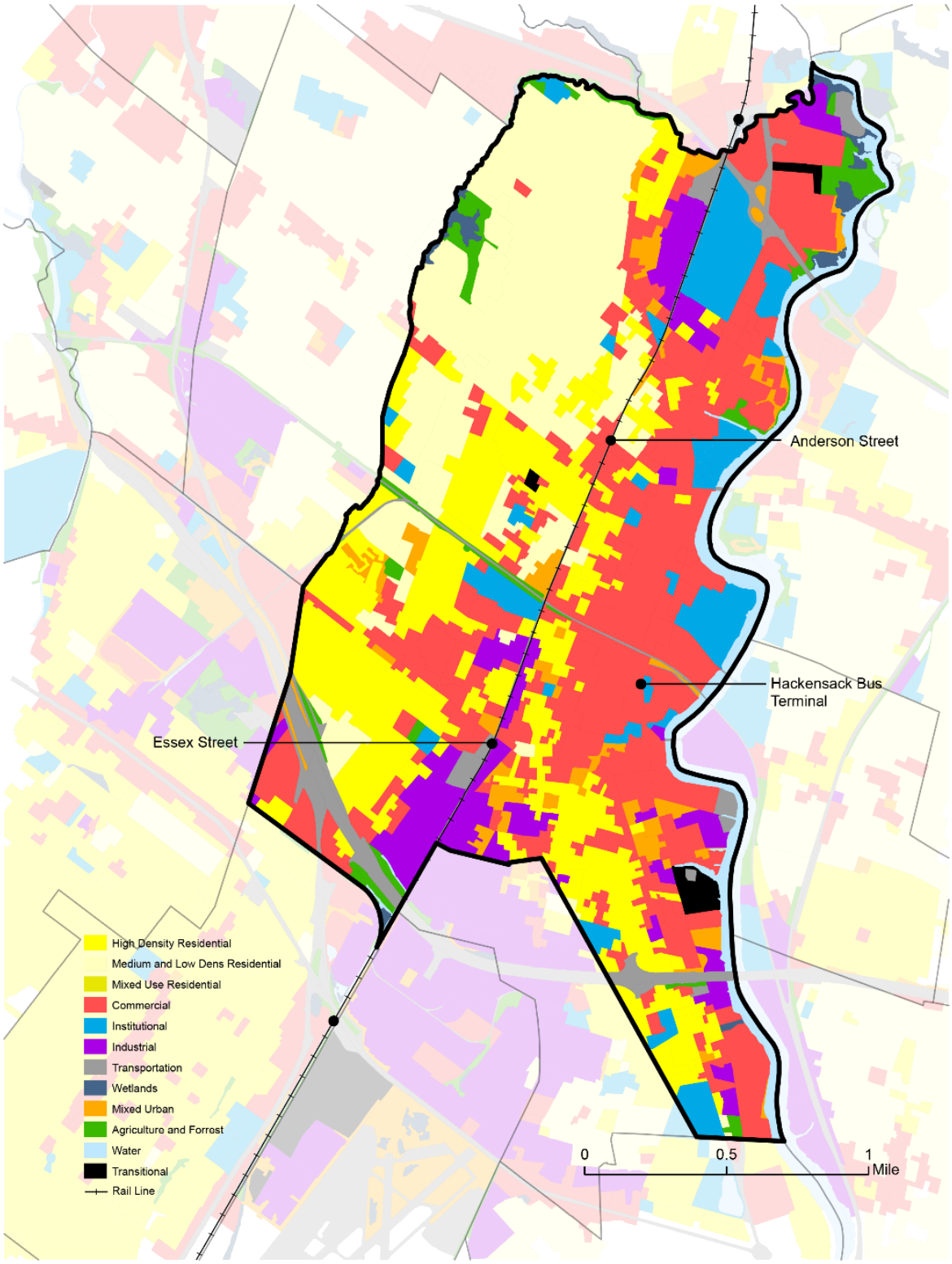

Figure 15. Hackensack Land Use Map

From the land use map in Figure 15 it is apparent that Hackensack is a densely built town with major institutional presence and already has a noticeable amount of Mixed Urban land – generally not a common land use throughout the state. The designated station, Hackensack Bus Terminal, is centered within the municipality's commercial area and is therefore very appropriately placed, within quick walking distance from the town's main street which is going through development changes to create density and mixed residential commercial uses. From a visual analysis the logic of designating the bus terminal over the rail stations is clear in that the surrounding area is the major focus of redevelopment efforts for Hackensack, rather than the industrial and lower residential areas surrounding the two rail stations.

Hackensack is a prime example of NJ Transit identifying a municipality with a strong smart growth vision in order to ensure designation and funding opportunities are provided to places that have done the legwork to move forward. The success of Hackensack's efforts can be seen extensively on their municipal website, which includes 20 redevelopment plans and lists public projects including the Performing Arts Center, the Atlantic Street park and Transit Village Designation. The municipality also has received a New Jersey Smart Growth award and a Public Partner award from NAIOP as a result of their intensive land use planning and redevelopment efforts.

Future actions include further placemaking efforts around where the arts center is located and the entrance to Main Street from the Bus Station as well as changing Main Street to accommodate two-way traffic, an action known to increase walkability and create safer driving conditions for pedestrians (Speck 2013). In summary Hackensack has had an internal drive to create a walkable engaging municipality for its residents and attract new economic opportunities for their downtown. The Transit Village Initiative was an opportunity presented by an academic

analysis of their town, which has been recently realized and will be leveraged in the future to help the municipality execute their vision.

Paterson – Rail

The City of Paterson was a considerably high scoring municipality, ranking 12 out of 327 in the study with an EPLI index score of 1.805. Paterson is not a Transit Village but does have a rail station and a bus terminal. The only Transit Village with a ranking above Paterson is Jersey City, while all other designated municipalities are ranked below.

Paterson's history is centered on industrial businesses and production of goods. Its inception in the late 1700s was a result of Alexander Hamilton's Investment Fund identifying a city to help relieve the United States' reliance on foreign goods by producing local goods. Another geological aspect of Paterson which was pivotal in choosing the location of this industrial city is the great Paterson falls, today a destination for local visitors. The falls were used to produce hydropower which served the businesses in the area. Since this time Paterson's economy has gone through some difficult times (Paterson, NJ).

Today Paterson is New Jersey's third largest city with a population of 147,000 people and is 8.704 square miles (Census 2010). Most of the jobs located in Paterson are considered working class, with employment sectors focused on services, transportation, and other industrial labor. Much of Paterson's population uses public transportation, often the bus, for daily commutes and college education rate is relatively low at 10.22%. Paterson is extremely ethnically diverse and also economically diverse, with a wide range in incomes. One of the most difficult issues Paterson has attempted to deal with is the high crime rate. Paterson has one of the highest rates of

violent crimes and crime overall is higher than in 88% of other New Jersey municipalities (Paterson, NJ). Provided below in Figure 16 is a land use map of Paterson.

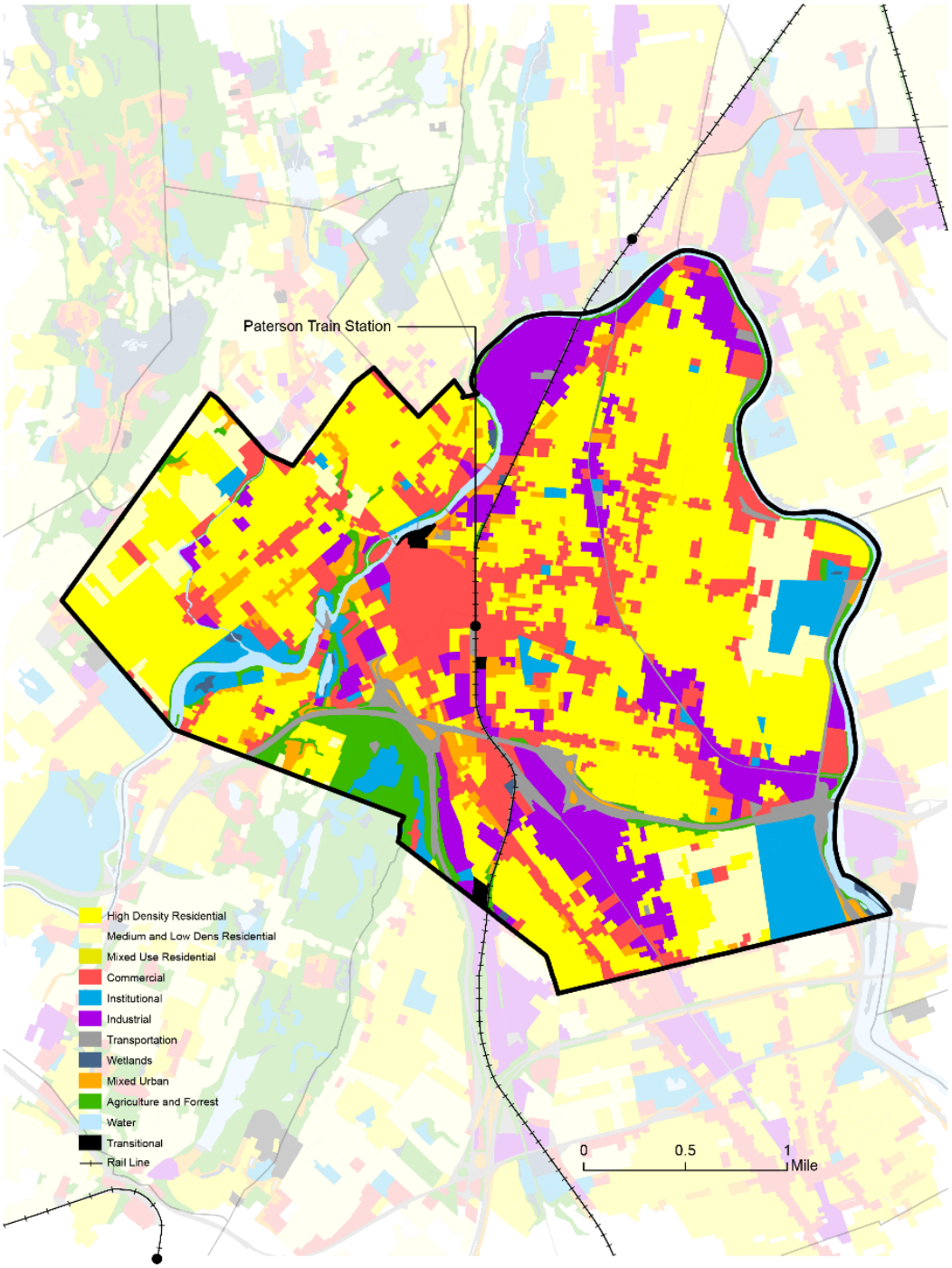

Figure 16. Paterson Land Use Map

This land use map provides context for how the municipality has developed. Its land uses are all very dense and remnants of its industrial history are visible by the strong presence of industrial land use. The commercial land use has the strongest presence around the rail station as is most appropriate for transit-oriented development in order to support a central node of development.

Though Paterson has indicated interest in the Transit Village Initiative, it is not clear if they have applied for designation. Independent of the Transit Village program, through its action plans and other planning documentation it is clear it has taken advantage of other programs and grants to improve the community. Table 9 presents some planning documents identified on Paterson's municipal website from the past few years, this may not be an all-inclusive list due to documents being located elsewhere or off the site.

Table 9. Planning Documents for Paterson

Document Type	Year
Paterson Transit Oriented Development Plan	September 2012
City of Paterson Masterplan	March 2014
St. Joseph's Hospital Redevelopment Plan	August 2014
Abandoned Property Ordinance	October 2014
Downtown Commercial Historic District Design Guidelines	December 2014
2015 Annual Action Plan	2015
Zoning and Land Development Municipal Code	April 2016
2016-2017 Annual Action Plan	2016

Paterson received a New Jersey Smart Growth Grant which helped fund their Ward Street Station transit-oriented development Plan, published in September of 2012. The intent of this 2012 plan was to outline a plan for growth around the rail station to encourage revitalization, mixed land uses, and sustainable living, moving development away from the old trends of building highways and parking lots. Much of the report stresses Paterson's need to retool its

transit station to focus on pedestrians and not on the vehicle, and, as is common in TOD, to focus on the area within a half-mile of the station. The report also points out the lack of use of the Ward Street Station, placing it at 63rd of 150 NJ Transit stations despite Paterson being in the third most populated municipality in the state. The report indicates possible reasons being the lack of safety and lack of commercial uses surrounding the station. The report identifies areas for improvement, strengths of the municipality, and proposals for accomplishing the outlined goals and objectives. At the end of the report three funding sources are listed that could potentially help Paterson fund these improvements from programs organizations and grants, one of which is the Transit Village Initiative.

As can be seen in the list of policy documents, Paterson annually executes action plans and identifies funding sources for improvements that would be most helpful to residents. Paterson's 2015 annual action plan indicated that the municipality was entering into agreements to receive technical services through other programs such as Together North Jersey Local Government Capacity Grant Program, executed by NJTPA and NJIT, with the goals of improving urban design to provide a better community. That same action plan indicated other focuses for the municipality to improve itself from affordable housing to identification of vacant or abandoned lots, outreach programs and healthcare assistance.

The most recent annual action plan for 2016-2017 continues these goals from previous action plans and listed out four grant opportunities where they anticipate receiving funding, including the Community Development Block Grant, HOME Investment Partnership Program, Emergency Solutions Grant, and Housing Opportunities for persons with AIDS/HIV. All these programs are focused on providing housing opportunities for lower income residents and providing health opportunities for those in need.

Not only has the community internally been identifying ways to improve itself for its residents and improve its urban design, but it has received attention from the greater region as well. Paterson was one of a handful of municipalities identified for long term development and integration into the New York Metropolitan region by the American Planning Associations fourth regional plan. The fourth regional plan set forth its vision for Paterson in 2040 as having direct service to New York and being a regional destination for jobs, its historic park, with a lively downtown. The plan also describes a vision for Paterson densifying its industrial lands and becoming more environmentally friendly while maintaining its affordability for existing residents. This vision aligns with what Paterson has been working to achieve in providing housing for residents, looking to create a sense of place, and aiming to provide economic opportunity for its residents (Fourth Regional Plan).

Though Paterson has not been designated a Transit Village and has very strong characteristics for this type of development, it is likely that it has not done so due to focus on other priorities and its focus on using other grant opportunities more targeted to the work it is trying to accomplish. From research on the Transit Village program, it seems as though the assistance the program could provide would be more beneficial to Paterson after or in tandem with addressing some of the more immediate issues that are more important to residents than designation. As indicated by the recent action plans, a focus on housing and affordability is a primary concern and much of the towns focus on grant applications has been in relation to this. Overall Paterson appears to show strong initiative on redevelopment similar to how many of the Transit Villages were in the years prior to designation, including Hackensack. An additional benefit to Transit Village Designation down the line for Paterson would be the coordination with

NJ Transit, working out the possibility of increasing service to the train station there, resulting in increased access and possibility for economic expansion to new markets in the region.

Montclair – Rail Transit Village

Montclair was in the top third of all municipalities scored, ranking at 67 of 327 with a score of 1.261. It is also known to be a good example of transit-oriented development in New Jersey. It is for these reasons it was chosen as a case study for this research. Montclair has a population of 37,837 and is 6.315 square miles in size (Census 2010). Montclair provides dense commercial areas as well as lower density residential and contains six rail stations with varying levels of service, from commuter to weeklong one seat rides into Manhattan.

The Bay Street Station received Transit Village designation in 2010 and has had eight years in the program, with a history of coordinating with NJ transit on redevelopment prior to its designation. Janice Talley the director of Planning and Community Development was able to offer her perspective on how the town has achieved transit-oriented development, the assistance provided by the Transit Village program, and the cycles of development seen in Montclair since as early as the 1970s.

The redevelopment history of Montclair is important to understanding goals and the focus of redevelopment in the municipality today. Rail service first came to Montclair, then West Bloomfield, in 1857, and decades later in 1913 it was replaced with the original Lackawanna Terminal (Godlewski 2017).

Redevelopment occurred in the 1970s and 80s in the area surrounding the historic Lackawanna Terminal. Lackawanna Terminal was designated a landmark in the early 1970s, and shortly after in 1981 the terminal closed. Redevelopment was targeted for this area as it was

determined to be blighted and in need of improvement, particularly after the station closure. During this time the typical development typology was suburban shopping centers, and the historic terminal was turned into a shopping center and renamed Lackawanna Plaza. With the retirement of the original Lackawanna station the new Bay Street station was constructed. During this time Montclair worked closely with NJ Transit to coordinate the construction of Bay Street and work out a more frequent schedule to provide a one seat ride to Manhattan. During this time the town continued to develop using a very suburban typology, including a gated residential community in close proximity to the Lackawanna station.

Over years the plaza has had many vacancies and what has been considered an overly large parking lot for the shopping center, making it once again a target for redevelopment. In the early 2000s Montclair began creating new redevelopment plans for the entire town embracing smart growth and transit-oriented development. Montclair created various components over the last decade and a half, these efforts can be seen documented and outlined in Table 10 below.

Table 10. Recent Montclair Redevelopment Plans

Plan Type	Year Adopted
Stormwater Management Plan Element	2005
Conservation Plan Element	2007
Housing Plan Element	2008
Historic Preservation Plan Element	2016
2016 Master Plan Reexamination Report	2016
Land Use & Circulation Plan Element	2017

As part of the recent redevelopment techniques Ms. Talley indicated Montclair has looked more to activate the street and integrate development into the community as opposed to the suburban sprawl redevelopment type that was embraced by the municipality in the 1970s and

1980s that resulted in an underutilized shopping center in their downtown. Speaking specifically to the Lackawana Plaza redevelopment it was indicated that current redevelopment plans involve coordinating with professionals to redesign the plaza and create structures fronting streets, activating them as opposed to having a plaza that is closed off and internal to itself.

The new Bay Street Station itself is located on Bloomfield Avenue close to where the original station was, which is Montclair's main commercial street and is the densest part of the municipality. While those involved in the designation are no longer working in the municipality, it was noted that interest in Transit Village Designation came originally from the Business Improvement District along Bloomfield Avenue. The local businesses hoped this designation would improve economic activity in the area. She noted that transit-oriented development in general is not overly embraced by residents, who prefer development away from the main station and commercial area to maintain the character of the town. Residents want their residential areas preserved and to keep denser development localized to the commercial corridor of Bloomfield Avenue, even though the town has additional stations throughout the municipality.

A major benefit of the designation was a $200,000 grant to execute a land use and circulation plan, as well as funding for a wayfinding plan for the area. The BID itself took the lead on executing the wayfinding plan. From the land use plan the municipality was able to move forward and target redevelopment areas and create redevelopment plans. These plans and Montclair's drive to revitalize certain areas have attracted developers, placing the town in the position of deciding what is most appropriate. Ms. Talley notes that in some cases that includes letting developers know their development type is not what the town is looking for and letting it go, which is necessary at times to achieve the development outcomes they're looking for, for example saying no to drive thru's.

Shown below in Figure 17 is the land use map for Montclair.

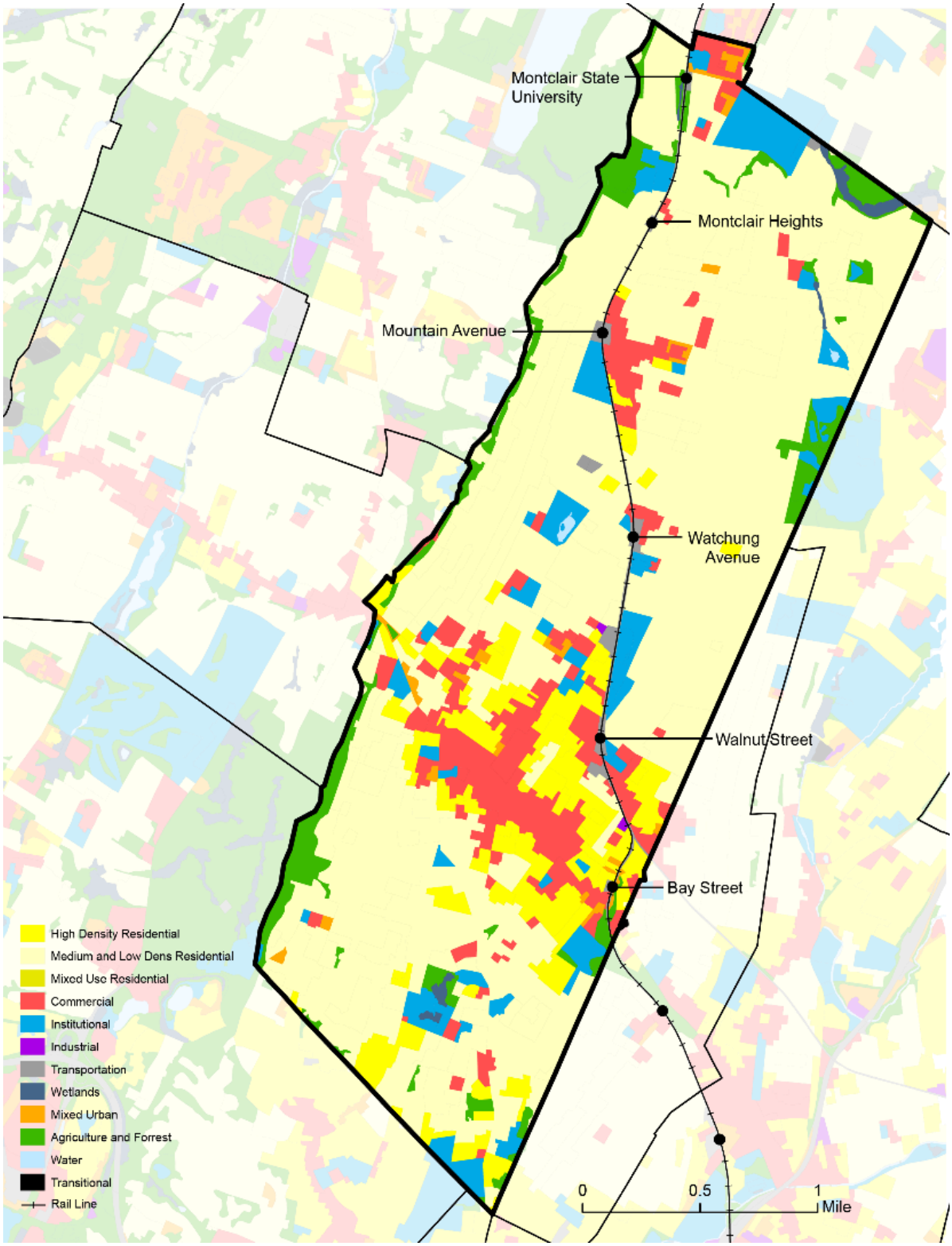

Figure 17. Montclair Land Use Map

The transit stops can be seen dotted along the rail line extending up north from the Bay Street station in the lower right of the municipality. The density surrounding the bay street station follows what has been found through development initiatives and Transit Village goals in that the remainder of the municipality has retained its lower density character, keeping TOD centered on the main station which provides the most frequent service.

In conclusion this closer look at Montclair has shown cycles of redevelopment and a more recent focus on what has now become understood as a more activating development type. The Transit Village Designation works well with Montclair's goals of redeveloping but keeping it localized to the station, allowing development within the Transit Village Initiatives indicated half-mile radius while at the same time maintaining the character of the community for the residents who are not as amenable to TOD.

Chapter 5: Summary

In conclusion, the state of New Jersey has many municipalities with great characteristics for TOD development. The Transit Village Initiative has over the years identified many areas most appropriate for pursuing developmental changes, in great part due to their requirements to entry and the legwork municipalities must accomplish in order to qualify.

From the research presented the outcome of Transit Village designation is very dependent on the municipality designated, their drive for change and how they embrace this development typology. While the designation provides a name and grant opportunities, the main driver for municipalities in their success in TOD is the years prior to designation and their independent work to improve their municipalities. For example, both Hackensack and Montclair had a history of supporting redevelopment for years prior to considering designation. Many found avenues for funding in addition to those of the Transit Village Program and had professionals within their municipality who were able to lead the town through developmental changes. This common thread of commitment ensures participants in the Transit Village program will continue to work towards their goals after designation.

While the index results do show the successes of the Transit Village program, the index also showed designated municipalities that were particularly low scoring, possibly resulting in lower characteristics of TOD to begin with or a lack of municipal drive for furthering this development type. The results also showed many municipalities, with rail presence and without, that have strong characteristics for smart growth and denser development. The Phillipsburg case study is a prime example of a municipality which once had constant rail traffic attempting to revitalize and redevelop its town to create more character and improve walkability. For this

municipality, improving development types, creating a destination for the region, and increasing density will all lead to an improved community and may even lead to a request for expansion of transit service. Phillipsburg's focus on urban design changes, economic development, and mixed uses are all techniques outlined by Calthorpe for TOD. These are places that should be looked at moving forward for expansion and connection into greater regions, as they have the existing bones to be able to support the transit-oriented development typology.

The bus-centered Transit Villages also contribute to this view of promoting municipalities without major rail infrastructure. Hackensack chose its bus station as it was more centrally located, and Mr. Dib also noted the incredible access that busses provide in New Jersey. The extensive coverage of bus service and access to Manhattan they provide is the reason that busses are widely used in areas not served by rail and even in areas that are served by rail. The high scores, particularly of Irvington which does not have rail in its municipality, show potential for developing transit in an area without heavy infrastructure. The flexibility that busses offer could allow a municipality to work towards TOD and consider coordinating at a later date for connection into the network once it has reached levels to support ridership. This concept and the study results show that enacting transit-oriented development techniques do not need to be focused on areas that have the strongest cases of transit but can be used to improve existing conditions and revitalize areas that have potential for improving their communities with or without transit.

There are a handful of municipalities that have been trying for designation as indicated by news articles from the past couple years. These municipalities include Garfield, Little Falls and Boonton, all three having a rail station. The interest in designation shows the importance to municipalities of being perceived as a Transit Village as well as the benefit of opportunities.

A final aspect that resulted of the case study presentations is that participation in the Transit Village program is likely contingent on their goals aligning with the municipality's goals. Paterson is an example of an area with prime TOD characteristics, and may or may not be targeting the Transit Village program, it is unclear. What is clear from their annual action plans is that the municipality targets grants and opportunities that lend themselves most to the needs of the residents in Paterson, improving economic opportunities and affordable housing opportunities. This example shows how many municipalities may find other opportunities more attractive to spend their resources on other than the Transit Village Initiative.

Regarding development trends in the state as a whole, New Jersey's state-wide redevelopment plan takes a large-scale view of where the state is focused on planning with techniques of Smart Growth. While this research is focused on transit-oriented development and removing the idea of transit as a requirement for starting TOD, "Smart Growth" largely has similar development techniques as TOD and it is worth mentioning the geographical extent to which New Jersey encourages these techniques. New Jersey's areas of interest cover all the high scoring areas identified through the EPLI index, indicating an awareness of the potential of these areas. These map identifiers provide identification to municipalities and developers to focus efforts in these locations which all coincide with high scoring areas from the TOD index. In Figure 18, mapped earlier this year, the similarities can be seen between the index score and New Jersey's Smart Growth areas.

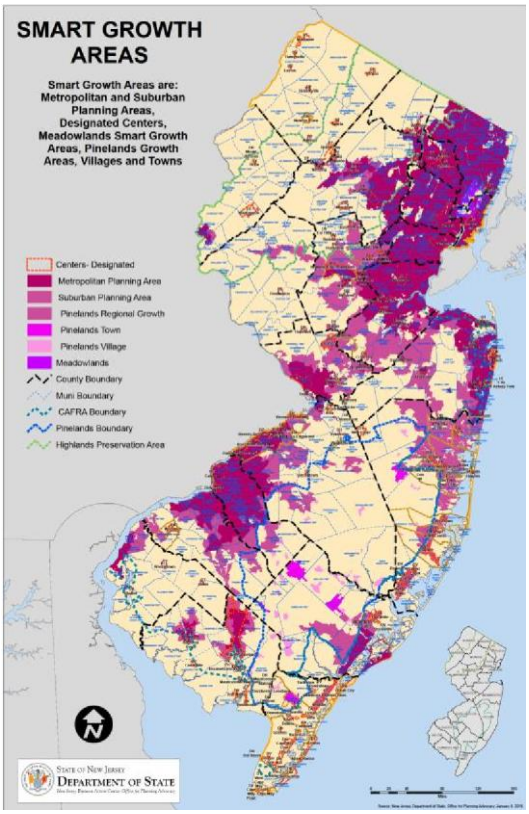

Figure 18. New Jersey Smart Growth Areas Credit: New Jersey Department of State, Office for Planning Advocacy

From review of the municipalities, it is universal that the high scoring municipalities target programs and development types that will allow them to improve their communities. Regardless of transit, these tenants of development can be implemented across the region and provide more potential to connect the region by transit in the future if the state and towns are able to build up to that point.

What can Planners Takeaway?

Transit-oriented development typology is generally focused around existing transit stations or around the planning of new transit stations, which is a hefty investment for municipalities if they do not already have it. This study proposes planners and municipalities

begin to think of transit-oriented development concepts outside of the traditional transit-centered viewpoint.

Given that many municipalities in New Jersey have great infrastructure for supporting a pedestrian centered environment, TOD does not always need to start with great transit access but can also potentially build up to great access, reaping benefits of walkability and community building along the way. Some definitions provided for TOD focus on development being built around transit as opposed to developing around highway and parking access. An alternate way of viewing TOD is developing around people centered uses as opposed to vehicle centered uses, were transit can be added in where appropriate and as it becomes a possibility financially and practically.

This can be seen from the work Paterson is doing to preserve its community character, working towards a better urban design with the opportunity to improve access to its existing transit station, which will eventually improve ridership demand. This can also be seen from the high scoring bus station Transit Villages. While limited in number, the bus centered Transit Villages of Irvington and Hackensack show the potential for municipalities to focus on their downtowns and main streets around transit without needing the heavy rail access that is often synonymous with TOD. And finally Phillipsburg New Jersey, a municipality with the least access to transit of the case studies, provides a strong historic development typology and a drive to create walkable mixed use areas, foreshadowing future potential to be able to support increased transit.

This study has shown how independent municipalities have executed TOD and smart growth on many levels and how they compare to each other. The state overall has identified appropriate areas to focus on, and has given municipalities of all types various grants to help

achieve their vision and goals. The proposed reuse of rail lines and work being done for light rail extensions also show regionally efforts to connect and reduce car use.

Being within the metropolitan region of one of the largest cities in America, New Jersey has a lot of opportunity surrounding beneficial connections and historic development typologies, but other parts of the U.S. can and have rethought their own development to focus on the same goals of TOD. This analysis proposes reframing the conversation around transit-oriented development to expand the reach of this development type to areas that may think their municipality isn't qualified but in reality has great base characteristics. Due to the history of the United States transportation network being heavily based on streetcars and railroads, there is likely a large number of areas with potential to regionally grow back their historic typology, if they have the desire to do so.

Study Limitations and Further Research

The methodology chosen for the Index does capture major measurements used in spatial analytics but does not capture all categories as outlined in Table 1. There are many alternate combinations of measurements and without comparison or a way to validate scores it is difficult to know what would produce the best results.

The datasets themselves did have limitations that should be considered when reviewing the data. A limitation of the land use dataset itself is that it includes broad categories of land use types, making it difficult to weight land uses that comply with transit-oriented development. For example, malls and downtown commercial areas would both show up as commercially designated and therefore would receive the same weighting in this category even though downtown retail would be more likely to support pedestrian trips and TOD. It is for this reason

land use was weighted half while the other categories were kept normalized to a value of 1, thereby including its importance but due to possible categorical skewedness not making it a primary factor.

Another limitation is the index measuring areas with respect to each other as opposed to objectively. This is a limitation noted in many studies of transit-oriented development and spatial analysis in general, as there is no objective method for measuring these types of attributes. This method of measuring by comparison did result in much lower scores overall in categories of employment density. Top scoring municipalities which received a value of 1 had significantly more employment density resulting in a large drop off for the remainder of the municipalities. This comparison method makes it difficult to give the appropriate ranking to municipalities that may score low in land use but for a more suburban area scores significantly higher on employment density because overall it is being compared to areas in close proximity to New York. These limitations are also reasons why the case study municipalities were important aspect of this study.

For further research, Sussex County should be included in the index analysis. Upon comparing the results with historic rail maps, it was apparent that Sussex County once had a strong rail presence which may or may not yield interesting results with respect to measuring characteristics of TOD.

Future research should also look into different characteristics of municipalities and analyze the towns to see if any are linked to participation in certain programs or execution of certain planning documents. Characteristics that could be looked at include resident age, median income of residents or proximity to New York to name a few. These are a handful of attributes that may or may not influence a municipalities ability to pay for the necessary planning services,

their ability to gain residents support for development types, and may indicate how much location influences development type.

Further research should also include additional interviews. While only two were able to be executed in this research, they are an important aspect of this study and offer a perspective on why towns approach development the way they do and who is in support or against this development type within municipalities. The couple of interviews able to be executed within the time constraints provided valuable understanding of the municipal context.

Interviews executed with non-designated towns should be stressed as an aspect of future research, as it would provide insight into their thoughts on executing TOD or smart growth without having a transit node. It would also provide insight into whether they had considered or were working towards increasing transit access, particularly in the form of bus, as from this research it is apparent that TOD typologies are just as strong if not stronger in bus station designated Transit Villages. Overall further interviews would allow insight into what additional programs municipalities are participating in, what actions they're taking, and who they are coordinating with to improve their communities.

Appendix A: Reference Tables

Urban 1000 Series		
1100		Residential
1110	0.9	High Density Multi Dwelling
1120	0.8	Single Unit Medium density
1130	0	Single Unit Low Density
1140	0	Single Unit Rural
1150	1	Mixed Residential
1200	0.8	Commercial and services
1211	0	Military Institutions
1214	0	Former Military; Indeterminate Use
1300	0.6	Industrial
1400	0.7	Transportation./Communication/Utilities
1410	0	Major Roadway
1411	0	Mixed Transportation Corridor
1419	0	Bridge Over Water
1420	0.7	Railroad Facilities
1440	0	Airport Facilities
1461	0	Wetland Rights of way
1462	0	Upland Rights of Way
1463	0	Upland Rights of Way
1499	0	Stormwater Basin
1500	0.8	Industrial and Commercial Complexes
1600	1	Mixed Urban or Built up
1700	0.8	Other Urban or Built-Up Land
1710	0	Cemetery
1711	0	Cemetery on Wetland
1741	0	Phragmites Dominate Urban Area
1750	0	Managed Wetland
1800	0.8	Recreational Area
1804	0	Athletic Fields (Schools)
1810	0.8	Stadium Theaters Cultural Centers and Zoos
1850	0	Managed Wetland in Built-up Maintained Rec Area

Agriculture 2000 Series		
2100	0	Cropland and Pastureland
2140	0	Agriculture Wetlands
2150	0	Former Agricultural Wetlands
2200	0	Orchards, Vineyards, Nurseries, horticultural areas
2300	0	Confined Feeding Operations
2400	0	Other Agriculture

Forest 4000 Series		
4100	0	Deciduous Forest
4110	0	Deciduous Forest
4120	0	Deciduous Forest
4200	0	Coniferous Forest
4210	0	Coniferous Forest
4220	0	Coniferous Forest
4230	0	Plantation
4300	0	Mixed Forest
4311	0	Mixed Forest
4312	0	Mixed Forest
4400	0	Mixed Forest
4410	0	Mixed Forest
4420	0	Deciduous Brush / Shrub land

4430	0	Coniferous Brush
4440	0	Mixed Deciduous Coniferous
4500	0	Severe Burned Upland Vegetation

Water 5000 Series		
5100	0	Streams and Canals
5190	0	Exposed Flats
5200	0	Natural Lakes
5300	0	Artificial Lakes
5400	0	Bays Estuaries & Other tidal waters
5410	0	Tidal Rivers Island Bays
5411	0	Open Tidal Bays
5412	0	Tidal Mud Flats
5420	0	Dredged Lagoon
5430	0	Atlantic Ocean

Wetlands 6000 Series		
6100	0	Coastal Wetlands
6110	0	Saline Marshes
6111	0	Saline Marshes
6112	0	Saline Marshes
6120	0	Freshwater Tidal Marshes
6130	0	Vegetated Dune Communities
6141	0	Phragmites Dominate Coastal Wetlands
6200	0	Interior Wetlands
6210	0	Deciduous Wooded Wetlands
6220	0	Coniferous Wooded Wetlands
6221	0	Atlantic White Cedar Wetlands
6230	0	Brush Dominate and Bog Wetlands
6231	0	Deciduous Scrub/Shrub Wetlands
6232	0	Coniferous Scrub/Shrub Wetlands
6233	0	Mixed Scrub/Shrub Wetlands (Deciduous Dom.)
6234	0	Mixed Scrub/Shrub Wetlands (Coniferous Dom.)
6240	0	Herbaceous Wetlands
6241	0	Phragmites Dominate interior Wetlands
6250	0	Mixed Wooded Wetlands
6251	0	Mixed Forested Wetlands
6252	0	Mixed Forested wetlands
6290	0	Unvegetated Flats
6500	0	Severe Burned Wetlands

Barren Land 7000 Series		
7100	0	Beaches
7200	0	Bare Exposed Rock
7300	0	Extractive Mining
7400	0	Altered Lands
7430	0	Disturbed Wetlands
7440	0	Disturbed Tidal Wetlands
7500	0	Transitional Areas
7600	0	Undifferentiated Barren Lands

Managed Wetlands 8000 Series		
8000	0	Managed Wetlands (modified

Appendix B: Interview Questions

Questions for Transit Village Designated Municipality Planners

- Was Transit Village Designation a straightforward process or was the municipality rejected and made to go through iterations until accepted by the program?
- Has the Transit Village Designation been effective and helpful in execution of Transit Oriented Development? If so what parts of the program have been most helpful (Grants, technical expertise, marketing ability as a TOD to attract developers)
- What techniques has the town used to attract new developers in the area? Has designation been important in this aspect?
- Was the focus on smart growth and TOD centered on transit or more centered on placemaking and development and planning of the town?
- Did any residents come to the town asking for this type of development or was it mostly municipality driven?

Questions for non-Transit Village Designated Municipality Planners

- Has your municipality tried in the past to apply for the Transit Village Program?
    - If so, what were the reasons for rejection?
    - If not, was the option of applying for the program ever discussed?
- What techniques has the town used to attract new developers in the area?
- If the township has extensive policy on smart growth ○ Was there a professional within the town planning program that was particularly versed in smart growth and transit-oriented development who led these policy changes for the municipality?
    - Did any residents come to the town asking for this type of development or was it mostly municipality driven?
    - Was the focus on smart growth centered on transit or more centered on place making?

Appendix C: EPLI Index Scores

Municipality	Max_VR_EPL	Category
West New York Town	2.422	R
Guttenberg Town	2.422	ND
North Bergen Township	2.422	ND
Hoboken City	2.091	R
Jersey City	2.091	RTV
Harrison Town	2.082	R
Newark City	2.082	R
Weehawken Township	2.081	R
Union City	2.081	R
Paterson City	1.805	R
Passaic City	1.750	R
Clifton City	1.750	R
Asbury Park City	1.694	R
Bradley Beach Borough	1.694	R
Neptune Township	1.694	ND
Fairview Borough	1.664	ND
Cliffside Park Borough	1.664	ND
Edgewater Borough	1.664	ND
New Brunswick City	1.614	RTV
Franklin Township	1.614	ND
Prospect Park Borough	1.503	ND
Haledon Borough	1.503	ND
Maplewood Township	1.501	R
Irvington Township	1.501	BTV
Carteret Borough	1.481	ND
Woodbridge Township	1.481	R
South Hackensack Township	1.478	ND
Hackensack City	1.478	BTV
Kearny Town	1.452	ND
East Newark Borough	1.452	ND

Elizabeth City	1.444	RTV
East Orange City	1.413	RTV
Garfield City	1.410	R
Perth Amboy City	1.403	R
South Orange Village Township	1.400	RTV
Ridgefield Borough	1.398	ND

Palisades Park Borough	1.398	ND
Fort Lee Borough	1.398	ND
East Rutherford Borough	1.397	RTV
Wallington Borough	1.397	ND
Maywood Borough	1.389	ND
Middletown Township	1.387	R
Hazlet Township	1.387	R
Keansburg Borough	1.387	ND
Linden City	1.385	RTV
Roselle Borough	1.385	ND
Edison Township	1.368	ND
Saddle Brook Township	1.343	ND
Elmwood Park Borough	1.343	ND
Bergenfield Borough	1.333	ND
Dumont Borough	1.333	ND
Hawthorne Borough	1.328	R
Monroe Township	1.323	ND
City of Orange Township	1.323	RTV
Bayonne City	1.320	R
Bloomfield Township	1.311	RTV
Belleville Township	1.305	ND
North Plainfield Borough	1.291	ND
Plainfield City	1.291	RTV
Nutley Township	1.289	ND
Piscataway Township	1.285	ND
Ridgefield Park Village	1.266	ND
Bogota Borough	1.266	ND
Teaneck Township	1.266	ND

Glen Ridge Borough	1.261	R
Montclair Township	1.261	RTV
Union Township	1.257	R
Hillside Township	1.257	ND
Lodi Borough	1.256	ND
North Arlington Borough	1.247	ND
Wood-Ridge Borough	1.246	R
Hasbrouck Heights Borough	1.246	R
Rutherford Borough	1.243	RTV
Morristown Town	1.237	RTV
Morris Township	1.237	ND
Lyndhurst Township	1.219	R
Leonia Borough	1.217	ND

Woodland Park Borough	1.213	ND
Summit City	1.212	RTV
Englewood City	1.208	ND
Long Branch City	1.206	RTV
River Edge Borough	1.202	R
New Milford Borough	1.202	ND
South River Borough	1.201	ND
East Brunswick Township	1.201	ND
Cresskill Borough	1.199	ND
Highland Park Borough	1.197	ND
Phillipsburg Town	1.196	ND
Carlstadt Borough	1.194	ND
Fair Lawn Borough	1.183	R
Glen Rock Borough	1.183	R
Dover Town	1.174	R
Rockaway Township	1.174	ND
West Orange Township	1.170	ND
Interlaken Borough	1.169	ND
Ocean Township	1.169	ND
Winfield Township	1.165	ND
Clark Township	1.165	ND

Cranford Township	1.165	RTV
Roselle Park Borough	1.153	R
Neptune City Borough	1.144	ND
Tenafly Borough	1.143	ND
West Long Branch Borough	1.143	R
Paramus Borough	1.132	ND
Metuchen Borough	1.126	RTV
Rochelle Park Township	1.116	ND
Rahway City	1.111	RTV
Kenilworth Borough	1.106	ND
Belmar Borough	1.105	RTV
Avon-by-the-Sea Borough	1.105	ND
Red Bank Borough	1.100	R
Moonachie Borough	1.100	ND
Keyport Borough	1.095	ND
Little Ferry Borough	1.094	ND
Totowa Borough	1.091	ND
Wayne Township	1.091	R
Manville Borough	1.085	ND
Hillsborough Township	1.085	ND

South Plainfield Borough	1.069	ND
Washington Borough	1.068	ND
Washington Township	1.068	ND
Englewood Cliffs Borough	1.062	ND
Raritan Township	1.062	ND
Springfield Township	1.059	ND
Garwood Borough	1.058	R
Westfield Town	1.058	R
Hillsdale Borough	1.057	R
Ridgewood Village	1.051	R
Watchung Borough	1.048	ND
Oradell Borough	1.047	R
Emerson Borough	1.047	R
Parsippany-Troy Hills Township	1.043	ND

Bedminster Township	1.041	ND
Lopatcong Township	1.024	ND
Old Bridge Township	1.013	ND
Sayreville Borough	1.013	ND
Westwood Borough	1.007	ND
Fanwood Borough	1.002	ND
Scotch Plains Township	1.002	ND
Spring Lake Heights Borough	1.000	R
Spring Lake Borough	1.000	R
Lake Como Borough	1.000	ND
Wall Township	1.000	ND
Teterboro Borough	0.995	R
Demarest Borough	0.993	ND
Haworth Borough	0.993	ND
North Brunswick Township	0.973	ND
Milltown Borough	0.971	ND
Millburn Township	0.962	R
Secaucus Town	0.959	R
South Amboy City	0.958	RTV
Midland Park Borough	0.956	ND
Wyckoff Township	0.956	ND
Boonton Town	0.947	R
Boonton Township	0.947	ND
Montville Township	0.941	ND
Eatontown Borough	0.938	ND
Verona Township	0.930	ND
Cedar Grove Township	0.930	ND

Union Beach Borough	0.924	ND
Brielle Borough	0.922	ND
Sea Girt Borough	0.922	ND
Manasquan Borough	0.922	R
New Providence Borough	0.922	ND
Holmdel Township	0.921	ND
Freehold Borough	0.918	ND

Freehold Township	0.918	ND
Washington Township	0.917	ND
Norwood Borough	0.913	ND
Northvale Borough	0.913	ND
Raritan Borough	0.912	R
Bridgewater Township	0.912	R
Monmouth Beach Borough	0.907	ND
Little Silver Borough	0.907	R
Fair Haven Borough	0.907	ND
Morris Plains Borough	0.904	R
Ho-Ho-Kus Borough	0.901	R
Waldwick Borough	0.901	R
Saddle River Borough	0.901	ND
South Bound Brook Borough	0.897	ND
Middlesex Borough	0.897	ND
Bound Brook Borough	0.891	RTV
Ramsey Borough	0.890	R
Pohatcong Township	0.888	ND
Somerville Borough	0.888	RTV
Manalapan Township	0.870	ND
Atlantic Highlands Borough	0.869	ND
Plainsboro Township	0.867	ND
Marlboro Township	0.862	ND
Pequannock Township	0.862	ND
Dunellen Borough	0.859	RTV
Little Falls Township	0.857	R
Caldwell Borough	0.855	ND
West Caldwell Township	0.855	ND
Shrewsbury Township	0.855	ND
Tinton Falls Borough	0.855	ND
Shrewsbury Borough	0.855	ND
Hackettstown Town	0.853	R
River Vale Township	0.850	ND
Park Ridge Borough	0.850	RTV

Montvale Borough	0.850	R
Livingston Township	0.848	ND
North Caldwell Borough	0.845	ND
Flemington Borough	0.843	ND
Spotswood Borough	0.843	ND
Aberdeen Township	0.833	R
Old Tappan Borough	0.833	ND
Oceanport Borough	0.832	R
South Brunswick Township	0.829	ND
Madison Borough	0.826	R
Alpha Borough	0.825	ND
Closter Borough	0.825	ND
Harrington Park Borough	0.825	ND
Randolph Township	0.824	ND
Bloomingdale Borough	0.821	ND
Butler Borough	0.821	ND
Florham Park Borough	0.816	ND
Berkeley Heights Township	0.815	R
Green Brook Township	0.815	ND
Greenwich Township	0.809	ND
Victory Gardens Borough	0.801	ND
North Haledon Borough	0.798	ND
Wharton Borough	0.796	ND
Wanaque Borough	0.793	ND
Chatham Borough	0.786	R
Long Hill Township	0.784	R
Essex Fells Borough	0.778	ND
Loch Arbour Village	0.776	ND
Allenhurst Borough	0.776	R
Deal Borough	0.776	ND
Rumson Borough	0.770	ND
Matawan Borough	0.765	RTV
Upper Saddle River Borough	0.761	ND
Rockaway Borough	0.758	ND

Mountainside Borough	0.753	ND
Franklin Lakes Borough	0.752	ND
Oakland Borough	0.752	ND
Sea Bright Borough	0.748	ND
Highlands Borough	0.748	ND
Mahwah Township	0.747	R
Chatham Township	0.740	R

Bernards Township	0.732	R
East Hanover Township	0.726	ND
Howell Township	0.723	ND
Jamesburg Borough	0.716	ND
Cranbury Township	0.715	ND
Woodcliff Lake Borough	0.711	R
Fairfield Township	0.707	ND
Pompton Lakes Borough	0.706	ND
Roxbury Township	0.699	R
Mount Arlington Borough	0.699	R
Bernardsville Borough	0.689	R
Allamuchy Township	0.688	ND
Hanover Township	0.682	ND
Allendale Borough	0.678	R
Roseland Borough	0.677	ND
Mountain Lakes Borough	0.669	R
West Milford Township	0.666	ND
Denville Township	0.661	R
Montgomery Township	0.647	ND
Riverdale Borough	0.643	ND
Helmetta Borough	0.643	ND
Netcong Borough	0.627	RTV
Mine Hill Township	0.616	ND
Mansfield Township	0.607	ND
Kinnelon Borough	0.603	ND
Lambertville City	0.596	ND
West Amwell Township	0.596	ND

Warren Township	0.582	ND
Belvidere Town	0.582	ND
White Township	0.582	ND
Lincoln Park Borough	0.552	R
Mount Olive Township	0.546	R
High Bridge Borough	0.537	R
Independence Township	0.536	ND
Branchburg Township	0.530	R
Chester Township	0.518	ND
Jefferson Township	0.508	ND
Clinton Town	0.503	R
Clinton Township	0.503	R
Ringwood Borough	0.491	ND
Readington Township	0.489	R

Mendham Township	0.487	ND
Washington Township	0.485	ND
Rockleigh Borough	0.485	ND
Alpine Borough	0.452	ND
Far Hills Borough	0.434	R
Harding Township	0.426	ND
Rocky Hill Borough	0.422	ND
Englishtown Borough	0.417	ND
Bethlehem Township	0.388	ND
Glen Gardner Borough	0.388	ND
Hampton Borough	0.388	ND
Mendham Borough	0.381	ND
Allentown Borough	0.379	ND
Upper Freehold Township	0.379	ND
Bloomsbury Borough	0.376	ND
Franklin Township	0.376	ND
Farmingdale Borough	0.370	R
Chester Borough	0.366	ND
Franklin Township	0.342	ND
Union Township	0.342	R

Colts Neck Township	0.325	ND
Lebanon Township	0.315	R
Califon Borough	0.311	ND
Tewksbury Township	0.311	ND
Holland Township	0.310	ND
Lebanon Borough	0.303	R
Frenchtown Borough	0.286	ND
Milford Borough	0.282	ND
Liberty Township	0.264	ND
Blairstown Township	0.252	ND
Hardwick Township	0.252	ND
Oxford Township	0.244	ND
East Amwell Township	0.243	ND
Peapack-Gladstone Borough	0.233	R
Delaware Township	0.221	ND
Millstone Borough	0.215	ND
Harmony Township	0.197	ND
Stockton Borough	0.171	ND
Alexandria Township	0.165	ND
Millstone Township	0.160	ND
Hope Township	0.156	ND
Roosevelt Borough	0.142	ND
Knowlton Township	0.135	ND
Frelinghuysen Township	0.106	ND
Kingwood Township	0.097	ND

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Figure	Sources
Figure 1	NJ DEP
Figure 2	NJ Transit, NJ DEP, NJGN
Figure 3	NJGN
Figure 4	NJ Transit, NJ DEP, NJGN
Figure 5	NJ Transit, NJ DEP, NJGN
Figure 6	American Rails
Figure 7	American Rails
Figure 8	NJ Transit, NJ DEP, NJGN
Figure 9	NJ Transit
Figure 10	Kofsky
Figure 11	NJ Transit, NJ DEP, NJGN
Figure 12	NJ Transit
Figure 13	NJ Transit, NJ DEP, NJGN
Figure 14	NJ DEP, NJGN
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Figure 16	NJ DEP, NJGN
Figure 17	NJ DEP, NJGN
Figure 18	NJ Smart Growth